RAILROAD GAZETTE

FRIDAY, JUNE 14, 1901.

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Contributions

Cast Iron Wheels and 50-Ton Cars.

New York, June 8, 1901.

TO THE EDITOR OF THE RAILROAD GAZETTE.

I have been for some time endeavoring to find an opportunity to write something on the subject of cast-iron wheels under 50-ton cars. . . . For your information I will add that thus far we have had no failures of the wheels under the 100,000 lbs. capacity coal cars which have been in service now more than one year, with the exception of two or three removals, due to wheels slid flat. I think you have covered the subject very completely.

S. M. P.

Chicago, Burlington & Quincy Railroad Co.
Chicago, May 28, 1901.

TO THE EDITOR OF THE RAILROAD GAZETTE.

I still have faith in the cast iron chilled wheel, and if the chilled wheel cannot be used under 100,000 lbs. capacity cars, it is so much the worse for the 100,000 lbs. capacity cars. I believe in giving wheel makers a chance to strengthen wheels. It is true that track conditions limit the flange thickness, but there are other ways of strengthening wheels and possibly better ways than simply thickening the flange. Specifications too stiff in some particulars may increase failures in another, so we ought to be careful how we overdo specifications.

F. A. DELANO, *Supt. Motive Power.*

The Baltimore & Ohio Railroad Co.
Baltimore, June 5, 1901.

TO THE EDITOR OF THE RAILROAD GAZETTE.

I thank you for the copy of your editorial on cast-iron wheels under 50-ton cars. So far as my personal experience is concerned, I have not yet seen any indications that the wheels under these cars do not meet requirements. I have had experience with 2,000 50-ton cars for the past two years. To pass an opinion on this matter would necessitate an investigation as to how the brakes are handled where excessive braking is required, also how the train is handled as to maximum speed. I have no doubt that the heating of the brake shoes has something to do with the development of seams. The shape of the pattern and the quality of iron used have also considerable to do with this question. In addition to this, the kind of truck is an important element. The difference of the strain on flanges between a truck which has no side motion and one under which side motion is permitted is an important element. I have not sufficient data to discuss the question with any authority, but my opinion at present is that with good material in the wheels, good manufacture, proper restrictions in the handling of trains where excessive use of brakes is required and properly designed trucks, the requirements of service under 50-ton cars will be fully met.

J. N. BARR, *Mechl. Supt.*

Philadelphia & Reading Railway Co.
Reading, Pa., May 27, 1901.

TO THE EDITOR OF THE RAILROAD GAZETTE.

Referring to your editorial on "Cast Iron Wheels Under 50-Ton Cars," I will state that I can conceive of no condition under which chilled wheels will not give satisfactory service under 100,000 lb. cars.

Thus far we have had no wheel failures under such cars, although up to the present we have had but limited experience with such equipment, both as to number of cars and period of time in service. From any information I may have gathered as to failures of chilled wheels in service above mentioned, I note that said failures are almost exclusively confined to worn and broken flanges, the broken flanges doubtless the result of wear and frictional heat induced thereby. This is not an inherent defect of the wheel itself, but is a result of defective truck construction and design, and of such accessories thereto as may be properly classified as belonging to the truck.

I doubt very much if the wheel flanges of trucks of 100,000 lb. cars under load are ever tangent to, or parallel with, the track on which they run, due to the fact that the enormous weight of 75,000 lbs. on center plate (some of which may or may not be carried on the side bearings) creates a frictional resistance to tangency which the track only corrects to the extent that the rail changing the direction of movement of truck must remain in hard contact with flange of leading wheel running on the same, even after the truck has "straightened out," and which condition continues until opposite curvature conditions cause the other rail to do the steering and then flange wear on opposite wheel sets in.

As to how is best to overcome the trouble, I venture the opinion as follows: Make the truck wheel base not less than six feet (if car construction would permit, the wheel base should be preferably 1½ times the gage of track), and provide the trucks with center plates of anti-friction design and of sufficient diameter to always carry the car body independent of the side bearings, which side bearings should never be in contact under load and would simply serve as safety stops to prevent extreme rolling. A truck worked out on these lines I believe will obviate all trouble with chilled wheels in heavy service. As to the poor quality or "cheap" wheels you speak of as the outcome of purchase conditions forced on the wheel makers by the railroads, it is true that such conditions have led to the manufacture of inferior wheels; but such wheels will fail as readily in 30,000-lb. service as in the heavier service of to-day.

S. F. PRINCE, JR., *Supt. M. P. & R. E.*

New York Central & Hudson River R. R. Co.
New York, May 28, 1901.

TO THE EDITOR OF THE RAILROAD GAZETTE.

Referring to your editorial on wheels for 50-ton cars, which appears in the *Railroad Gazette* this week; the New York Central & Hudson River R. R. Company is operating some 100,000-lb. capacity cars over its lines. We have in constant service about 5,000 80,000-lb. capacity cars of our own which are heavily loaded and are subjected to the severest service of any cars that we operate. I recently made special investigation as to the breakages of wheels under these cars and found practically an entire absence of flange breakages, except in three instances of slightly chipped flanges caused by some obstruction in a frog during the winter.

There is in vogue in the eastern part of the United States a practice on hilly roads of controlling trains when descending long grades by the application of the hand brake instead of the air brake. On roads where this practice is followed, the instructions are that the trainmen shall release the brakes on the cars on which they are set before the wheels become excessively heated, brakes being applied on other cars for a short time. The question arises whether the instructions are being lived up to, if not, there would be a strong probability of wheels being excessively heated to a point where they would be liable to fracture. Is it not likely that many of the cases of flange breakage in wheels on cars of 100,000 lbs. capacity are caused by the practice outlined above? I believe it is a fact that on mountain roads near the Pacific slope, trains are controlled almost exclusively by means of the air brakes. These brakes put the work of retarding the train upon all the wheels in the train, partly relieving the pressure on them occasionally, while the cylinders are being recharged and avoiding the possibility of a continuous maximum application of the brakes on any one set of wheels to a point where the heating would be dangerous.

I have inquired of the representatives of several roads who are using 100,000-lb. capacity cars continuously, and they say that they have no excessive breakage of flanges. I have made similar inquiry of representatives of one or two other roads and find that their experience is entirely different. May it not be that the difference in experience is caused by a difference in practice, which can be obviated, and thereby eliminate the destructive effects on the wheels? It goes without saying that heavy capacity cars should have heavy wheels, carefully designed, and made of a high grade of material. Ordinary prudence would seem to require greater care in the selection of material for cars that carry excessively heavy loads than for cars which carry light loads, especially when the dimensions of flanges are restricted on both classes of wheels to the same limits.

It seems to the writer too early to condemn the cast iron wheel for heavy car service. First, it would seem desirable to clearly develop the actual cause of the failures; then consider if it is not possible to eliminate the cause of failure rather than to eliminate the cast iron wheel.

A. M. WAITT, *S. M. P. & R. S.*

Chicago, May 24, 1901.

TO THE EDITOR OF THE RAILROAD GAZETTE.

The value of the iron or steel wheel is not to be measured by the opinion of any one but by results alone. The requirements of service under heavy cars are undoubtedly very much more severe on the wheels than the lighter cars; but while a considerable increase is shown in the failures and breakages of wheels in this heavy service yet it does not follow because some makes of wheels have failed to meet these new conditions that all iron wheels have done so or that the iron wheel is not competent to fill all the requirements of this increased load. We have no hesitation in furnishing wheels for these extra heavy cars, provided we are allowed to use our judgment as to what constitutes the best method of manufacture for such wheels. We have furnished a vast number of wheels under heavy capacity cars during the past few years, and the railroads using them have had little or no trouble from their breakage or rapid wear. We believe that we have possibly anticipated some of the increased requirements of this class of service, and compensated for them in the manufacture, and that this accounts for our lack of failures as compared with other types and makes of wheels.

Too much stress is laid upon what the wheel is made of, or what it is cast in, and too much attention is given to constructing a car wheel which will be capable of resisting a specific test which has been called for but which provides for only one of the many causes of failure in car wheels. We believe that every condition of service must be compensated for and where these compensations interfere with each other they should be approximately modified. In other words, if impossible to supply the maximum of resistance for one requirement of service without detriment to the resistance of another requirement of service, then both should be modified and railroad companies will have to regulate the quality and the weight of their car wheels largely to the weight which they have to carry, as that is the real and only test. Fifty years ago approximately the same flange was required for a 10-ton car traveling 5,000 miles a year as is now provided for a 50-ton car making 15,000 miles per year; fifteen times the work with little or no change in the flanges, and little or no more increase possible now, on account of track conditions. The use of self-couplers has made it possible for the flange of some one wheel to be called upon for more resistance than could possibly be required under the old coupling system and generally makes flange work more severe.

Of one thing there can be no question, the load which a car is capable of carrying is and will be regulated largely by the flanges, and herein comes the question of the possibility of a steel wheel being used in place of iron. Eliminating the almost prohibitive question of difference in price, the fact remains that the life of all steel wheels as demonstrated by service is even more largely in the flange than is that of the iron wheel, and should the steel wheels be increased in hardness to compensate for this extra work which the flanges will have to do, that will increase the tendency to broken steel flanges in as great if not a greater degree than chilled iron ones. The chilled iron flange now offers greater wearing resistance than any steel flange made, and yet the general complaint is that an iron wheel shows a greater tendency to flange wear under heavy cars.

It is also a recognized fact that steel wheels under heavy loads are inclined to very rapid wear and that under bad brake practice, such as sliding wheels, they are even more apt to fail than iron ones. When the difference in the care and attention which has been given to steel wheels in passenger service is compared with that of the iron wheel under freight cars and on mountain roads, one can readily see that whatever the measure of service has been for steel wheels compared with iron in passenger service, they will not furnish any reliable data as to what these steel wheels will do in a vastly different service and under much more severe requirements at least so far as mileage is concerned, and when with this is considered the possibility of increased accidents due to sharp flanges on steel wheels, it can be reasonably said that from any standpoint the steel wheel cannot be considered as yet to have any advantage over a good iron car wheel properly constructed to meet special requirements of heavy freight service. We at least are perfectly willing to make such tests of service with our iron wheel so constructed as against any steel wheel made.

T. A. GRIFFIN,
President Griffin Wheel Co.

Buffalo, N. Y., May 27, 1901.

TO THE EDITOR OF THE RAILROAD GAZETTE.

Your editorial on cast-iron wheels under 50-ton cars deals with a matter of great importance to railroads and wheel makers.

We have had considerable experience in the manufacture of wheels for 50-ton service, having made upwards

of 20,000, and have yet to hear of the first case of breakage. The greater number of these wheels have been in service between three and four years, and general renewals for all causes have not been out of the ordinary. Since the introduction of the 50-ton car we have maintained the position that wheels for such service should be made of the best material and of proper weight and section, and when prices did not admit of such practice we have not supplied the wheels.

So much might be said on the subject of the quality of chilled wheels now manufactured to sell at competitive prices that it would not be possible to do that part of the subject justice, and besides it is likely that buyers of the lowest-priced wheels know quite well what can be expected from them. To make the best or even a good ordinary quality of chilled wheel is not possible without a selling price that admits of the use of good material and practice. Between the lowest price paid and the price at which a first-class wheel can be sold there is a margin of about one-half cent per pound. For this additional amount wheels made of good charcoal chilling iron can be obtained as against wheels made of non charcoal iron and manganese mixtures.

It is contended by some wheel makers and railroad officials that charcoal chilling iron is not necessary for the production of good chilled wheels. The writer believes it is absolutely necessary. A cause of failure referred to in the editorial is cracks at the junction of tread and flange, causing pieces of the flange to break off. It is likely that this may be partially due to the use of manganese mixtures, for the reason that the adhesion of the crystals of chilled iron in such mixtures is very slight. The total lack of adhesion between crystals of ferro-manganese is well known and readily seen on the most superficial examination of the metal, and the same tendency exists in mixtures which are given chilling properties by the use of ferro-manganese.

There can be no doubt about the necessity for increased flange strength in wheels for 50-ton cars, and it must be obtained entirely from the quality of metal used. Flanges cannot be increased in thickness on account of the fixed limits of space in frogs, crossings, switches, etc. The support for flanges cannot be increased to any extent, although it is possible to lower the bottom of wheel brackets slightly, considering the general section in use.

The use of large axles necessitates coring wheel hubs to much larger sizes than ordinary. In ordinary practice variations in size of cores are provided for by lessening the section of ring cores forming the double plates. The very large center cores used, after allowing for proper thickness of metal and hubs, do not leave a proper section of double plates. To remedy this defect an entirely new outfit of ring core pans, patterns, etc., is necessary, and yet it is doubtful if it has been made as a rule.

Taken altogether, the manufacture of wheels for 50-ton car service is not a matter to be undertaken without a full knowledge of what the very severe service needs and the use of ordinary qualities and weights of wheels is not likely to give satisfactory results. Not only is this a question for roads owning such equipment, but it is equally so for roads making repairs upon it. To put even a few wheels for repairs under such equipment is a matter of grave importance, for one or two wheels can do damage enough if they are not of the quality and weight to stand the service.

The question is receiving very careful consideration from a number of leading railroads and it is gratifying to find some instances of action of exactly the kind outlined in your editorial, viz., the buying of wheels made of first-class material, which are paid for at prices that admit of the best practice. Such cases are not as frequent as we hope they will be, but a good beginning is being made. If the 50-ton car is to be used one of its first necessities is certainly wheels that will stand the service. It may cost $25 to $30 more per car to obtain them instead of wheels that can be obtained at the lowest price. There is absolutely no reason why chilled wheels of good quality should not be considered equal to the service because the cheapest quality will not answer.

As to the use of steel wheels, perhaps the additional cost of equipping a car with the best chilled wheels would buy one steel wheel of proper quality, and multiplying that sum by eight is not productive of totals that will lead to very large experiments of that kind.

We have manufactured quite a large number of high-grade chilled wheels in recent years for passenger, locomotive and other special service, and have succeeded in obtaining results of strength and resistance far beyond our expectations. We see no reason why progress in the same line cannot be continued to fully as great an extent in the future. If it is possible to make chilled wheels that will stand five hours' continuous tests under Master Car Builders' specifications without showing the slightest sign of failure, it can hardly be said that there is a falling off in progress in this line of manufacture in recent years.

P. H. Griffin,
President New York Car Wheel Works.

Steel in Car Building.

BY JOHN M. HANSEN, *Chief Engineer Pressed Steel Car Company.*

The subject of steel underframes to replace ordinary types of wooden car equipment has received much attention in the past year. As a result a large number of cars have been equipped with underframes of various types. Practically all of these have been made of pressed steel, although several designs of underframes have been suggested which are composed almost entirely of rolled shapes.

In the past nine months the wooden car department of the Pressed Steel Car Company alone has built over 6,000 cars with wooden bodies of ordinary design supported by a steel underframe in place of wooden sills. The underframe illustrated in Fig. 1 has been used on a large number of P. & R. box and gondola cars built by the Pressed Steel Car Company. It consists of two center and two side sills, of pressed steel standard type, 17 in. deep at center, extending continuously from end sill to end sill. Each section of this sill is of channel form. The flanges form an ample bearing surface to which wooden nailing strips can be bolted, and also afford abundant opportunity for riveted connection with top and bottom flanges of end sills and bolsters. The bolster is of a box girder section, the web of which consists of channel-shaped diaphragms, which are flanged on all sides to allow center sills to pass through and still furnish riveting surface sufficient to connect the ends of these diaphragms, and thus get the efficiency of a continuous bolster. The tension and compression members of this bolster consist of flat tie plates extending continuously the entire width of the car, passing above and below the center sills, thus holding the latter securely in place.

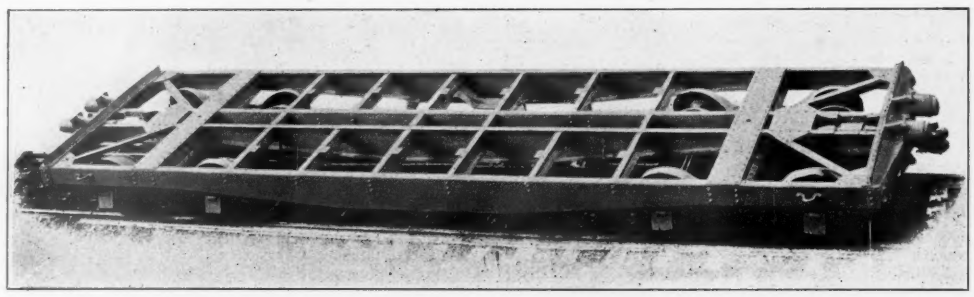


Fig. 1.—Pressed Steel Underframe for Philadelphia & Reading 80,000-lbs. Capacity Box Car.

The end sills of the car constitute girders which assist in distributing a part of the force due to end shocks from center sills to side sills. The connection between the end sills and side sills is strengthened against distortion by a gusset plate, to which a diagonal brace is attached. The other end of this brace is attached to center sills at bolster. The intermediate stringers, or nailing strips, are supported at short intervals by cross braces, which are riveted to side and center sills. These braces also serve to keep the frame square, and in case of a local load directly above the center sills these braces convey part of the load to the side sills, where it can be more readily cared for. This frame, with attachments for wooden upper structure, is shown in Fig. 3.

The advantages of the steel underframe are greater than was at first foreseen. The strength of the car is, of necessity, made ample for 80,000 and 100,000-lb. loads, as it is scarcely possible to obtain sections of steel which are light enough to make 50,000 and 60,000-lb. cars economically. By the use of a steel underframe it is possible and practical to build an 80,000-lb. furniture car (or a car for any other bulky commodity) with truck centers 50 ft. apart, if so desired. With a wooden underframe it would be literally impossible to place sills close enough together and make trussing deep enough to accommodate such a span. There is not room enough between top of rail and top of floor in the ordinary design of wooden cars to truss the sills sufficiently to carry the load which an 80,000-lb. car is expected to carry, across a span of 50 ft., unless an excessive number of sills and truss rods are used, which would make the weight of the car so great that it would be an impracticable construction. By the use of steel sills, such as are manufactured by the Pressed Steel Car Company, it is possible to get a girder which is practically of uniform strength at all sections. The weakest point of the wooden sill is, under ordinary circumstances, at the center of the car. The

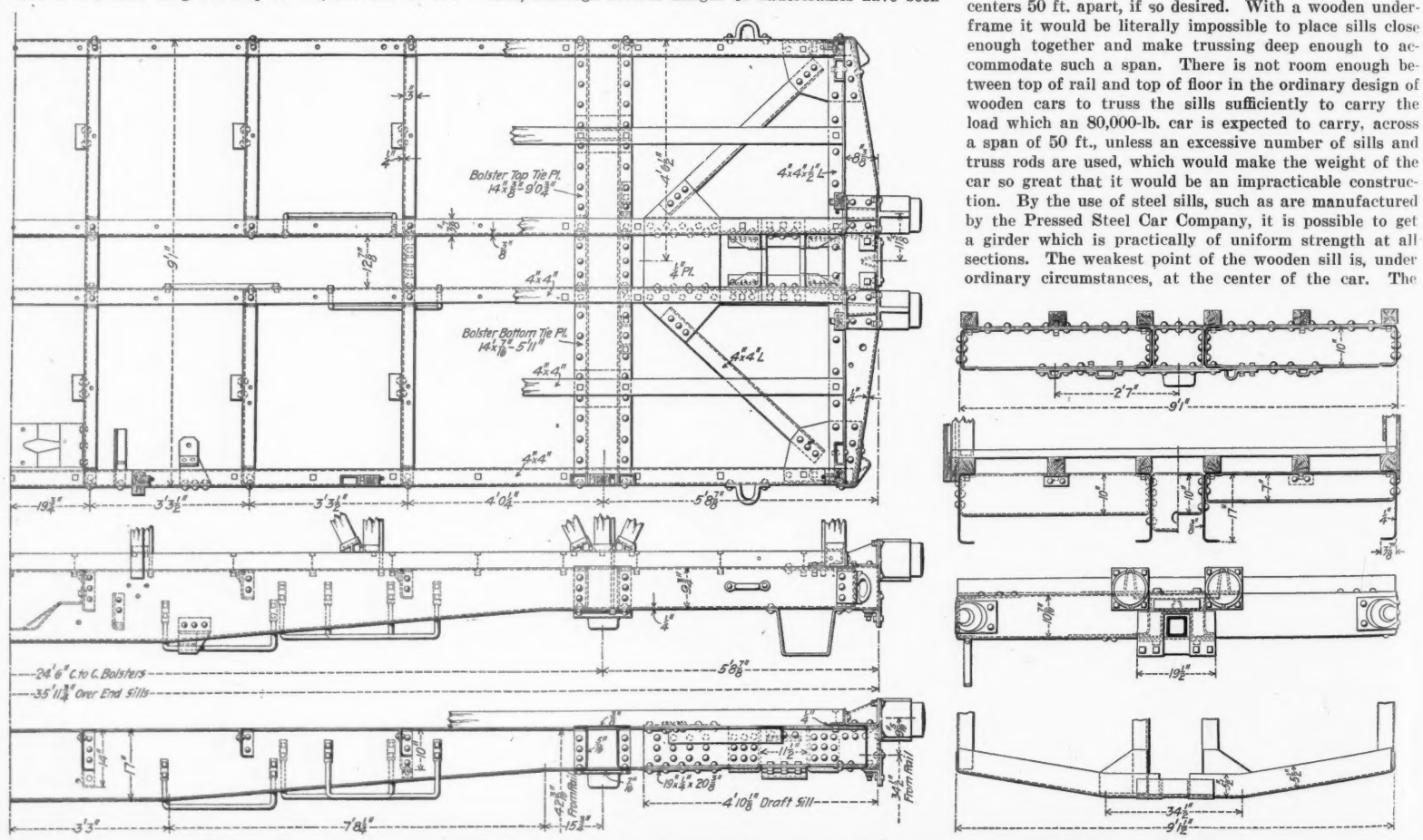


Fig. 3.—Pressed Steel Underframe for 80,000 lbs. Capacity Box Car with Wooden Upperstructure—Philadelphia & Reading.

truss rods, which, in a new car with wooden sills, support the greater part of the vertical load, soon lose their initial tension, and allow the sills themselves to carry the greater portion of the load. It is at this time that the weakness in the sills develops. With a pressed steel sill, such as that described above, it is possible to make the sill stronger at the center than at any other point. This, it is claimed, cannot be done with wooden sills. The portions of the center sills between the bolsters are called upon to stand compression due to blows sustained by the draft rigging. In this case, also, the weakest point of the wooden sill is at the center of the car. The tie rods, which help to strengthen the car against a vertical load, only serve to exaggerate this weakness. The humping-up and breaking at the center, which frequently causes the destruction of a long flat car when it sustains heavy end shocks, is prevented by the use of a steel frame.

Inability to resist end shocks is one of the most fatal weaknesses of present car construction. The underframe described above, affords abundant opportunity for exceptional strength in this direction. The diagonal braces, which are shown in this design of underframe, form the tension members of a truss by which compression of the draft sills is partially communicated to the side sills. These same diagonal braces act as compression pieces to convey the shocks sustained from pushing on the corner of the car where the push-pole is applied, to the center of the car, where they are readily absorbed by the bolsters and center sills. In a box car a common casualty is for the end post to be broken out at the bottom. In Figs. 1 and 3 an angle is shown riveted to the top flange and the bottoms of the end posts and braces are secured behind this angle. The end posts and ends of the car cannot, therefore, break away from their connection at the bottom without tearing off or bending this angle. The strength of the end of the car is thus limited only by the strength of the opponent timbers, and not by the strength of the various joints.

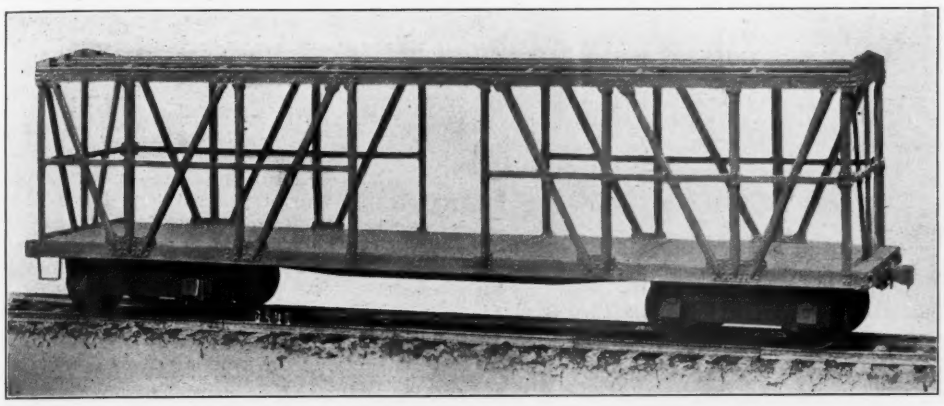


Fig. 2.—Complete Pressed Steel Frame for 80,000-lbs. Capacity Box Car.

Since the adoption of the steel underframe has proven of such great value, another move in the same direction has been suggested, and is being adopted with equal rapidity for box car service. In addition to a steel underframe, cars are now being designed with steel posts, braces, side plates, end plates, carlines, etc., thus making the frame of a box car a complete riveted structure. Fig. 2 illustrates a complete steel frame as built by the Pressed Steel Car Co., and Fig. 4 shows in detail the construction of a car having such a frame. The posts and braces are U-shaped.

A nailing strip, to which the lining is secured, is bolted on the inside of each post. The side and end girths are of U-shaped section, and form a continuous steel band encircling the entire car, with the exception of the door openings. A nailing strip is also placed inside these girths, and others are placed along the side plate and side sills, forming a nailing surface for car siding. The side plate consists of a channel section running from end to end of the car. The end plates are angle sections, and are riveted at their ends to the side plates. The side plates are further connected by carlines of U-shaped section. The carlines have curves pressed in them into which the purlines are fitted and bolted.

The practical advantages to be derived from this steel upper frame are probably as great as, if not greater than, those derived from the steel underframe. The wooden box car has long since reached its limit as regards capacity and durability. The metal frame which is now being introduced, opens the way for increasing the capacity and life, and reducing the cost of maintenance of box cars. The 100,000 lbs. capacity box car will form a considerable part of the cars manufactured in the near future. It is needless to argue the economy of a 100,000-lbs. car by comparing its cost and paying load with the cost and paying load of a 60,000-lbs. car, as this was discussed exhaustively before the use of 100,000 lbs. hopper and gondola cars became so common. The superiority of a steel structure as compared with a wooden structure to withstand the elements has been discussed and acknowledged in many other branches of engineering than car designing, and it is, therefore, unnecessary to advance any arguments along this line. Suffice it to say that wooden bridges on railroads all over the country have been replaced by steel bridges, and wooden buildings by steel buildings. These facts make it reasonable to assume that it is only a question of time until wooden cars will all have been replaced by steel cars. A virtue which is seldom advanced for a steel frame lies in the fact that fire has no effect upon it. This was clearly illustrated in a recent fire which involved a car with a metal frame. The fire entirely destroyed all woodwork on the car, but left the frame in good condition, thus averting 30 per cent. of the loss which a wooden car would have sustained.

Whereas it is undoubtedly a fallacy to design cars to withstand wrecks or unfair usage, yet the fact that steel cars and steel underframes do withstand wrecks which result in total destruction of wooden cars is certainly a point in their favor. The question has always been, "Where does fair usage end and unfair usage begin?" The use of steel frames has been of great value to railroad companies in that it has widened the limits of what is considered fair usage, and narrowed down the amount of usage which can be termed unfair. Without any visible signs of extraordinary usage a steel frame has frequently been known to stand what has in the past been considered unfair usage, inasmuch as it resulted in demolishing wooden cars.

With the steel frame illustrated in Fig. 2 the entire side of the car becomes a steel truss, the necessity for the heavy side sills used in the steel underframe immediately disappears, and even then the side of the car is still at least 50 per cent. stronger than the vertical load can possibly require. The reason for this is, that in addition to supporting this vertical load the posts and braces must also resist the centrifugal force, or bulging effect, which results from rounding curves at high speed with a loaded car.

To give a general idea of the efficiency of the steel post, or brace to stand compression, or to show the ability of a steel upper frame to support a vertical load, the following comparison is made:

The prevailing practice in wooden car construction is to secure a post merely by putting it in a malleable iron shoe, which means nothing more than a hinge or pin connection. The method of securing steel posts is to rivet them to the side plate or side sill, thus making it fixed or rigid at both ends, which gives the steel post a great advantage over the wooden post. However, overlooking this advantage, and comparing the U-shaped steel post shown in Fig. 2, made of ¼-in. plate, with a solid oak post of the same over-all dimensions, it is found that the wooden post is capable of standing only 30 per cent. of the load that a steel post of equal length can carry with safety. In the computation, the result of which is given above, a wooden post is assumed as capable of standing a maximum fiber strain of 1,000 lbs. per sq. in., while a steel post is assumed as capable of standing 12,000 lbs. per sq. in. These assumptions are certainly fair, or possibly favor the wooden post.

To show the advantages of a steel post vs. a wooden post, to resist bulging or bending, calculations have been made which clearly demonstrate that a steel post, acting as a beam, can resist three times the force that would break a wooden post of the same over-all dimensions and of ¼-in. thickness. The steel underframes and upperframes here considered are both steps in the direction of a box car the outside covering of which will be entirely of steel. Considerable interest attends the developments in freight car equipment which will take place within the next year and the 100,000 lbs. capacity steel box car will probably play an important part.

The Chemistry and Manufacture of Steel Axles.

BY C. E. MIDDLETON.

A few years ago the railroad engineer was trying to decide whether he would use iron or steel axles. To-day he is undecided as to what quality of steel will give him the best results. Most of the axle specifications of to-day call for steel made by the open-hearth process. To meet this clause the axles must be made of basic open-hearth steel, as the question of price will keep any manufacturer from using an acid steel with phosphorus under 0.07 per cent. Bessemer steel will not be used under specifications that do not mention the process of manufacture, for the same reason.

In considering the chemical composition of steel for axles, the amount of carbon has probably received the

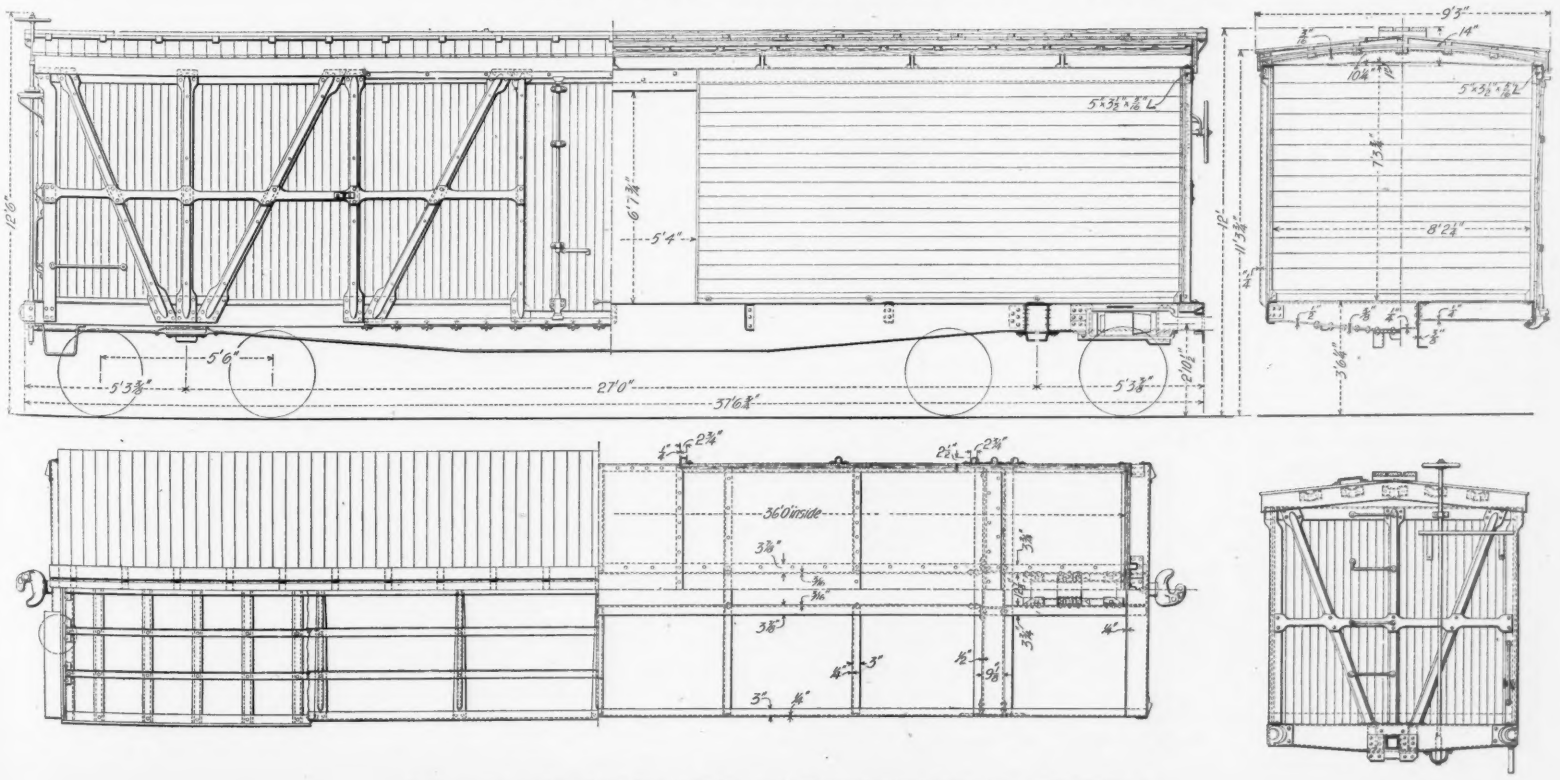


Fig. 4.—80,000-lbs. Capacity Box Car with Pressed Steel Framing.—Pennsylvania.

most attention. Many of the railroads demand a high carbon steel, and to-day the axle makers are using steel that a few years ago would have been considered entirely too high in carbon. The M. C. B. specifications for car axles limit the axle makers to the use of steel ranging from 0.35 to 0.50 per cent. of carbon, while the specifications proposed by the American Section of the International Association for Testing Materials leave the carbon contents to the maker.

While the range of percentage of carbon allowed by the Master Car Builders' specifications is large enough to satisfy the manufacturer, it would probably be better to allow him to decide upon the percentage of carbon he wants to use to meet the required tests. The fact that the axles must stand the specified drop tests makes it necessary to use a quality of steel that will be hard enough to meet the requirements. The fear of disastrous results under the drop and the trouble to be met with in working the steel will cause the manufacturer to refrain from using a steel that is too high in carbon.

Some engineers favor the high carbon, and several are advising a percentage above 0.50. The reason given in most cases for desiring a higher carbon is that the axle will be stiffer. Very little can be said in favor of higher carbon, and when the results of a thousand or more tests made on axles manufactured under the M. C. B., or similar specifications show that very few axles have been rejected because they were too soft to withstand the test, the evidence is rather conclusive that the carbon is high enough to meet the requirements. The percentage of carbon in the axles tested, as shown by the heat analyses, varies from 0.30 to 0.50 per cent. and will average 0.39 per cent. In a few cases axles containing a much lower percentage of carbon, as shown by the drillings taken from the axles, have passed the test. The few failures of axles while being treated show that the carbon is high enough to give good results. In testing, one axle represents at least 25 or 30 axles and the percentage of failures during service due to softness is not large enough to signify that the carbon is too low. If the impact test as required by the specifications of to-day has any value there can be very little argument in favor of using higher carbon steel. Experience shows that steel with carbon ranging from 0.30 to 0.40 per cent. and with normal percentage of manganese, phosphorous, sulphur and silicon will give satisfactory results.

In many cases a failure, said to be due to detail fracture, is blamed upon the softness of the material. If such failures could always be properly investigated the cause of fracture would often be found to be due to some defect in the structure of the steel rather than to its softness. With an increased carbon the chances of failure will be greater. Wide changes of atmospheric temperature are severe upon axles and must be taken into account. Excessive and sudden shocks and the practice of cooling hot journals with water will show their effects more readily upon the high carbon steel.

Where the percentage of carbon is high in a heat of steel the segregation is greater and more care must be taken to insure a uniform lot of blooms. In ordinary rolling mill practice the evils of segregation cannot always be avoided and the proper amount of discard is not always made. In some heats of steel 15 to 20 per cent. discard will remove all danger from segregation; in others more discard will be necessary and the presence of pipes, blow holes, etc., may cause the manufacturer to throw aside the entire heat. With an increased carbon the bad effects of phosphorous and silicon will become more noticeable, but when the fact is taken into consideration that most axles of to-day are made of basic steel there is not much to be feared in this direction. The percentage of manganese, phosphorous, sulphur and silicon is always low enough to be unharmful, unless segregated. Every consumer should reserve the right to make a check analysis on drillings taken from the finished axles, in order to be protected against segregation.

The soundness and uniformity of a heat of steel is of as much importance as the chemical composition. Axles made from a heat of steel that is sound and reliable though a little too soft or hard cannot be as dangerous as if made from steel which has been improperly treated in an open-hearth furnace, blooming mill or axle shop. The chemical analysis and tests will not always reveal such mistakes and the manufacturer must be depended upon to furnish a good quality of steel. That he does so, is shown by experience, as every step in the manufacture is left to him until the axles are ready to be tested.

Care must be taken in working the steel that is now used in axle making as it is an easy matter to overheat and so injure it that an inspector will not discover what has happened. The reverse may happen and the steel will go to the hammer man just a little too cold to be worked properly. The axle maker is depended upon to guard against such occurrences. Careless work in forging, which does much to injure the steel, is avoided to a large extent by the honesty of the hammer man and the fact that he will not be paid for work that is not satisfactory.

The improvements made in the methods of manufacturing axles to-day, have greatly reduced sources of trouble. The practice of heating first one and then the other and forging has been dropped in some places and the blooms are heated in a continuous furnace. The blooms are charged on one side and slowly pushed through to the opposite side of the furnace. By this method the steel is heated evenly throughout. The bloom leaves the furnace on a conveyor and passes through a set of rolls which reduces it from a bloom to a round about 1 in. larger in diameter than the finished size of the wheel seat. This round is then taken to the hammer and the axle is forged at the one heat and laid aside to slowly cool. This method of heating eliminates the danger of having an axle that had one-half forged at one heat and the other half at another. To do the required forging while the axle is at the proper heat it is necessary to have hammers that are heavy and fast enough to give best results.

A few years ago it was deemed advisable to anneal axles, but of late, axles go into service as they leave the cooling table and give very good results. The methods of annealing at some plants were probably more harmful that good.

Axles with smooth forged finish should leave the hammer with dimensions as near the required sizes as possible and be free from injurious seams, hammer marks and surface defects. Rough turning when required should be carefully done as sharp tool marks will fix a line of fracture as is sometimes shown during the drop test. It would be better to use axles with smooth forged finish, as the rough turning removes much of the steel that has been benefited by the work done in forging.

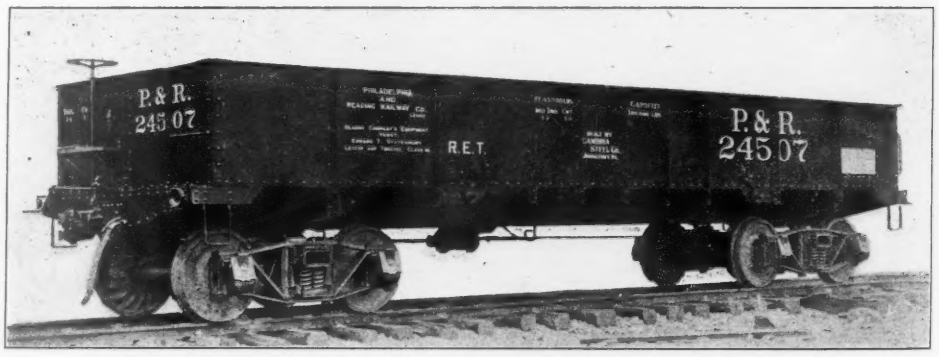
The question of finish is one that the railroad engineer can probably settle to suit himself as the manufacturer is prepared to give him what he wants. In many cases rough turning will remove surface defects that would cause an inspector to reject an axle if it were to be smooth forged.

New 50-Ton Steel Gondola Cars.

In our issue of Jan. 18 last we published the drawings of a 50-ton low-side gondola car for carrying rails, structural shapes, pig iron, etc., and a 50-ton drop-bottom gondola car. These cars were designed by Mr. L. M. Slack and built by the Cambria Steel Company. The accompanying engravings from photographs show the finished cars.

The low-side gondola is a sample car, and when photographed was loaded with 138,000 lbs. of steel billets. Its light weight is 30,000 lbs. The drop-bottom gondola shown is one of the 500 cars building for the Philadelphia & Reading. The light weight of this car is 33,300 lbs.

100,000-lbs. Capacity Low-Side Steel Car—Cambria Steel Co.



100,000-lbs. Capacity High-Side Steel Car—Philadelphia & Reading.

The most interesting feature of these designs is the omission of the side sills and the use of the plate girder construction instead of sills. In these cars the sides not only confine the load but carry their due proportion of it. The center sills, two 15-in., 33-lb. channels, form a stiff back bone. Common commercial rolled shapes are used throughout with a view to facilitating repairs.

In the low-side gondola, it is necessary to extend the sides a short distance below the floor so as to get the required strength, but in the P. & R. car the omission of the side sills entirely removes an obstruction to seeing beneath the car. As shown by the engraving, an inspector alongside this car can easily examine the brake gear, bolsters, trucks and other parts which are often difficult to see.

The P. & R. gondola is 34 ft. long by 9 ft. 2 in. wide inside, and the sides are 42 in. high. The side plates can either be made continuous throughout the car or spliced at the middle, these plates forming the web of the side girder. The upper girder flange is an angle, and the lower flange a base angle riveted to the side and floor plates. The stiffeners are vertical angles, which extend below the floor and are riveted to the ends of the intermediate cross channels. Four drop doors are provided in the floor. The body bolster consists of vertical web plates between the center sills and sides with flange angles riveted to the top, bottom and ends. In this way the web plates are connected to the sides and center sills, the floor and upper cover plate, and to a bottom cover plate. The draft gear consists of follower plates and three coil springs side by side, the outer coils being in line with the webs of the center sills. The follower stops are formed by riveting reinforcing strips alongside the openings in the sills, the followers bearing directly against these plates and the web of the sills. The follower plates are steel castings.

The low-side gondola is similar in construction, and has the same length and width as the high-side car. The center sills are 15-in. channels, the body bolster construction is the same as described before, and the cross-intermediate channels in this car are joined by angles to the web of the side girders.

Diamond frame trucks are used with bolsters built up of structural shapes. The upper arch bar is 1⅜ x 5 in., the lower arch bar is 1¼ x 5 in. and the tie bar is ¾ x 5 in. The dimensions of the detail parts of these cars were given in connection with our description of Jan. 18.

Locomotives for the Great Northern Railway.

The Great Northern has ordered 30 locomotives from the Rogers Locomotive Works, to burn bituminous coal, 10 passenger and 20 freight. The passenger engines (A) are of the ten-wheel type, and the freight engines are all consolidations. Ten freight engines (B) have single expansion cylinders and narrow fire-boxes; five (C) have single expansion cylinders and wide fire-boxes, and five freight engines (D) are two-cylinder compounds with narrow boxes.

The principal dimensions are as follows:

	A.	B.	C.	D.
Type	10-wheel	Consol.	Consol.	Consol.
Cylinders, diameter, in.	19	20	20	22 & 33
Cylinders, stroke....in.	28	32	32	32
Driving wheel base, ft. and in.	13 6	16 0	16 0	16 0
Total wheel base, engine .....ft. and in.	24 10	24 3	24 3	24 3
Total wheel base, engine and tender, ft.in.	58 0	58 0	58 0	58 0
Weight on drivers, lbs.	130,000	172,000	172,000	174,000
Weight on truck...lbs.	30,000	20,000	20,000	21,000
Weight, total .....lbs.	160,000	192,000	192,000	195,000
Boiler, type	Straight top	Straight top	Straight top	Straight top
Boiler pressure ....lbs.	210	210	210	210
Fire-box, type.....	Belpaire	Belpaire	Belpaire	Belpaire
Fire-box, length.....in.	112	123	118	123
Fire-box, width.....in.	41½	41½	72	41½
Heating surface, tubes, sq. ft.	2,082	2,500	2,500	2,500
Heating surface, fire-box .....sq. ft.	172	212	200	212
Heating surface, total, sq. ft.	2,254	2,712	2,700	2,712
Grate area,.....sq. ft.	32	35.3	59	35.4
Grate, type	Cast iron rocking	Cast iron rocking	Cast iron rocking	Cast iron rocking
Flues, material.....	Iron	Iron	Iron	Iron
Flues, number	280	340	340	340
Flues, diameter ....in.	2	2	2	2
Flues, length,....ft. in.	14 3	14 8	14 8	14 8
Driving wheels, material	Cast steel	Cast steel	Cast steel	Cast steel
Driving wheels, diameter .....in.	73	55	55	55
Driving axle journals, in. x in.	9 x 12	9 x 12	9 x 12	9 x 12
Driving wheels, diameter .....in.	36	33	33	33
Truck wheels, diameter, in. x in.	6 x 12	6 x 12	6 x 12	6 x 12

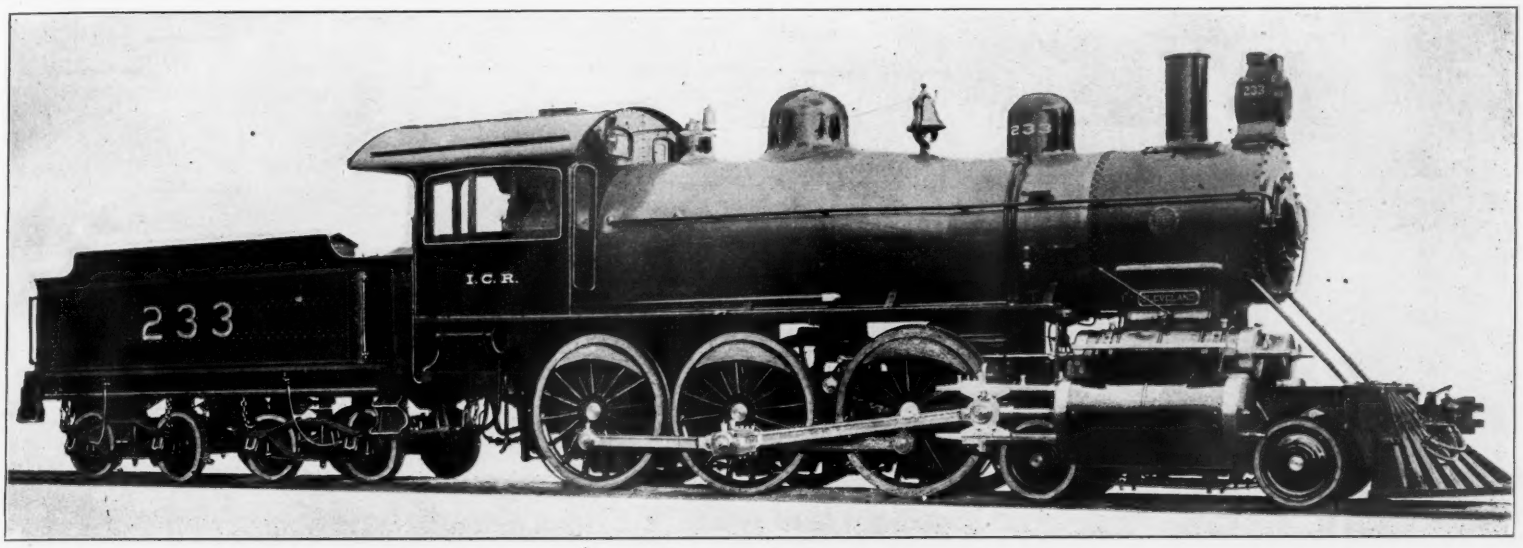
All engines have brick arches in the fire-boxes supported on water tubes, hopper bottom ash pans, Richardson balanced slide valves, Krupp tires and New York air-brakes. The tenders are alike for all. These have four-wheel trucks and underframes made of 12-in. steel

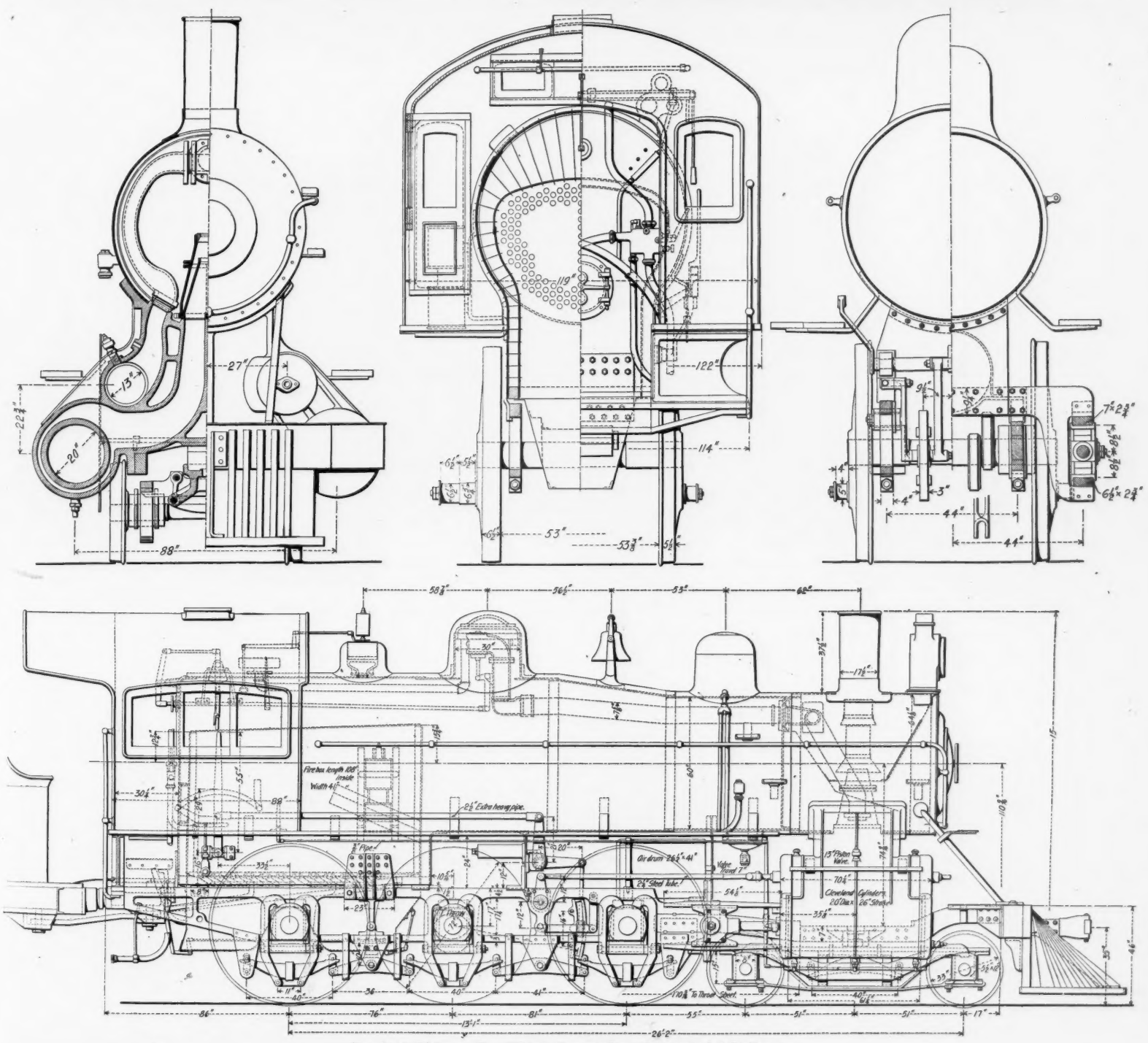
channels. The capacity for water is 6,000 gallons and for coal, 11 tons. The trucks are of the diamond frame type, with 36-in. wheels. The journals are 5½ x 10 in.

Intercolonial Locomotives With Cleveland Cylinders.

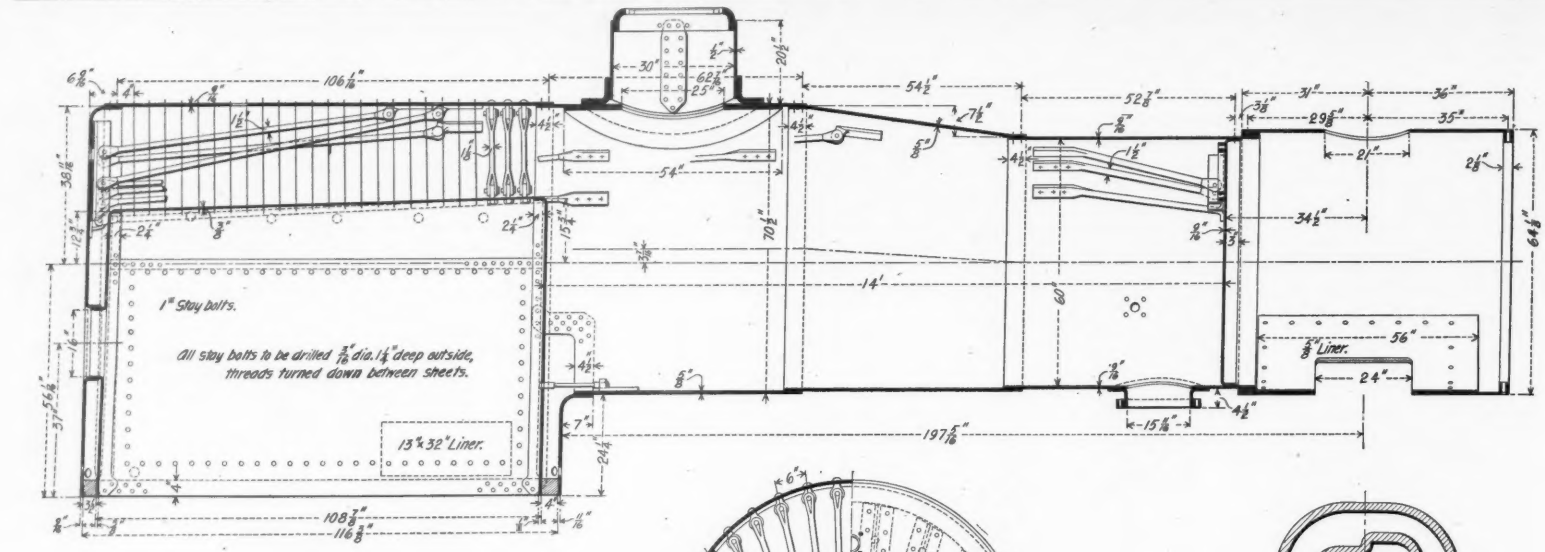
In the *Railroad Gazette* of Aug. 5, 1898, was a description of the Cleveland locomotive cylinder as applied to a 16 x 24-in. passenger locomotive of the Intercolonial Railway of Canada. At the same time a proposed modification of this cylinder was shown, the differences being mainly in the arrangement and length of steam and exhaust ports and in the style of valve used. The modification as then shown is essentially the design that is now being used under the patents of Messrs. William F. and Eugene W. Cleveland, with whom Mr. A. M. Peterson, of Colborne, Ont., is interested in placing this type of cylinder on locomotives. The Intercolonial recently ordered from the Dickson Locomotive Works seven 10-wheel and five consolidation engines to have these cylinders, and there were previously on the Intercolonial one 8-wheel passenger engine and one consolidation. Of the Dickson order one passenger engine and one consolidation engine were completed several weeks ago, and were worked for a while on the D., L. & W. Railroad out of Scranton, Pa., where they did satisfactory work. These engines, it is intended, shall be exhibited at the Pan-American Exposition, and the order will be finished during the summer.

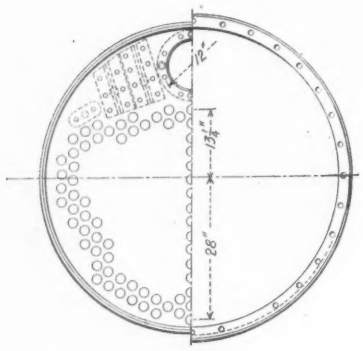
The Dickson passenger engine which is here illustrated has cylinders 20 in. in diameter with 26-in. stroke, and the driving wheels are 72 in. outside diameter over tires. The weight on driving wheels is 124,000 lbs., the weight on truck wheels 46,000 lbs., making the total weight in working order 170,000 lbs., and the tender loaded weighs about 92,000 lbs. The boiler is of the extended wagon top type, carrying 200 lbs. working steam pressure, and has a fire-box 108 in. long, 41 in. wide, 71¾ in. deep at front and 68¾ in. deep at back. The heating surface in the fire-box is 177 sq. ft.; and in the tubes 2,023 sq. ft., making a total of 2,200 sq. ft. of heating surface for a

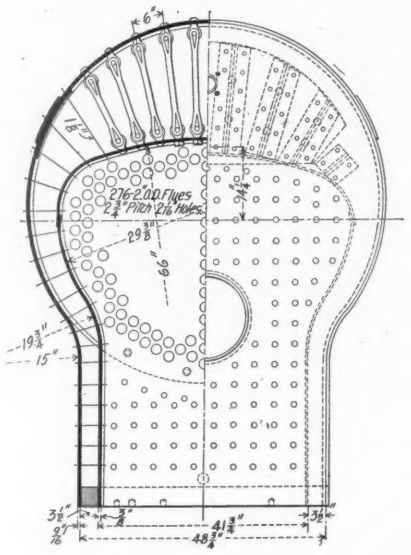




Cleveland-Dickson Ten-Wheel Locomotive—Intercolonial Railway.


1" Stay bolts.
All stay bolts to be drilled 7/16" dia. 1 1/4" deep outside, threads turned down between sheets.
13 3/4 x 32" Liner.
3/8" Liner.





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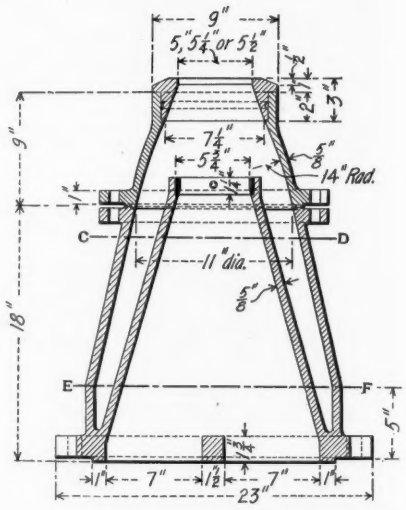
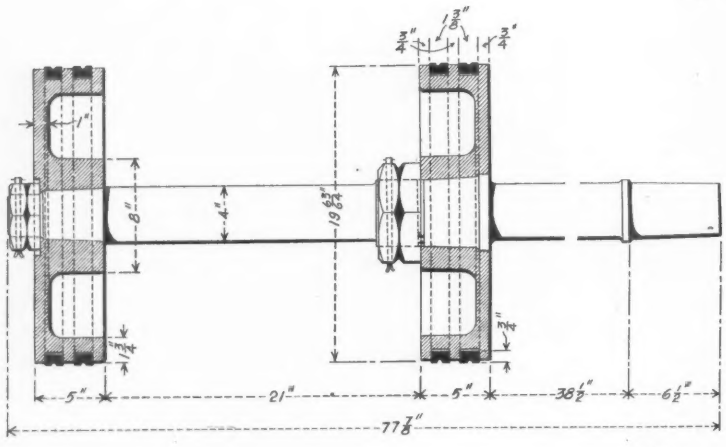
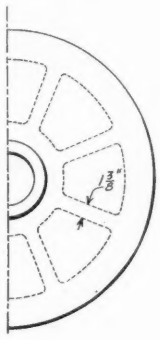
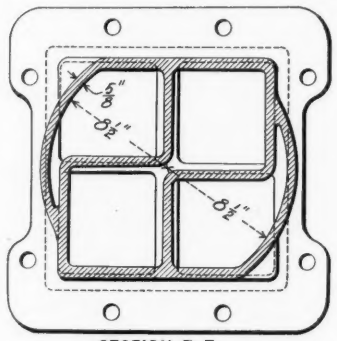
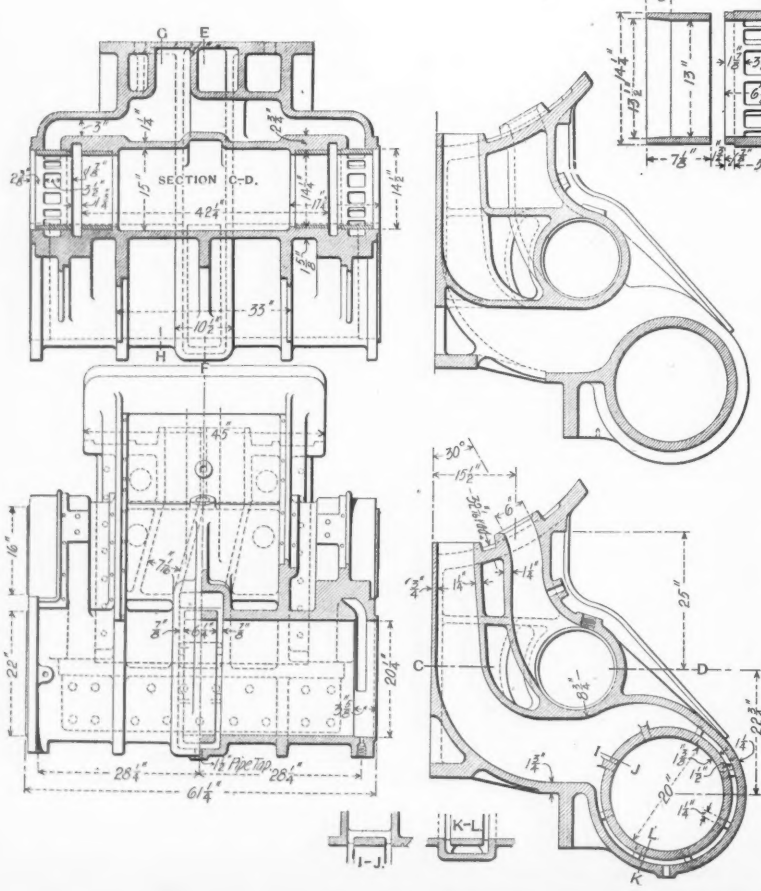







SECTION E-F.



General and Detail Illustrations—Cleveland Ten-Wheel Locomotive for the Intercolonial Railway.

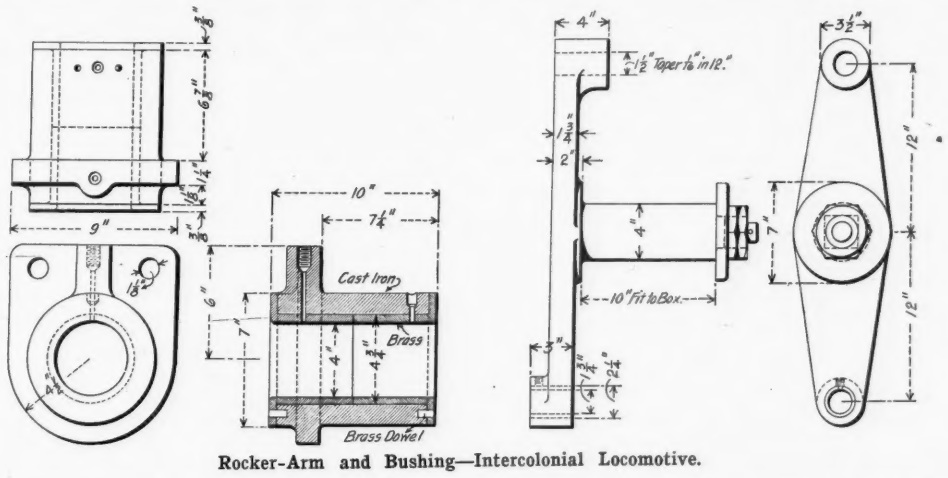
grate area of 30.75 sq. ft., the fuel being bituminous coal. There are 276 2-in. tubes 14 ft. long over tube sheets. The frames are wrought iron, and the driving wheel centers are steeled cast iron. Piston valves with internal admission are used, the length of the valve being such as to make the admission ports short and direct, thus reducing the cylinder clearance to a minimum. The rocker arm and other parts of the valve gear are somewhat out of the ordinary, both arms of the rocker being inside of the frames and the rocker shaft extending through a bushing set in the frame. The rocker shaft is retained in the frame by a nut set on its outer end, and the motion is received from the link through a short transmission bar, the link radius being 60 in.

The above mentioned features and all other points of especial interest are illustrated herewith, and the half-tone illustration from a photograph of Engine No. 233 shows the general effect of this design. The cylinder and valve action, with the exhaust nozzle arrangement, are the distinctive features of the design, and in view of the importance of this order now being filled for the Intercolonial it may be timely to review principles involved in the cylinder action, thus supplementing what we have already published in regard to it. It is clear that the central idea is to provide means for expanding the steam throughout a greater proportion of the stroke than is ordinarily possible and to insure prompt exhaust, reduction of back pressure, and control of compression. From the drawings of the cylinder it is evident that twice the ordinary length of cylinder is used in addition to the space required at half length, where the main cylinder exhaust at long cut-offs is made through ports ⅞ in. wide and completely encircling the cylinder. Between the two heads of the double piston with which each cylinder is fitted there is thus an exhaust cavity, or chamber which fills that duty, in the double piston, always in communication with the atmosphere.

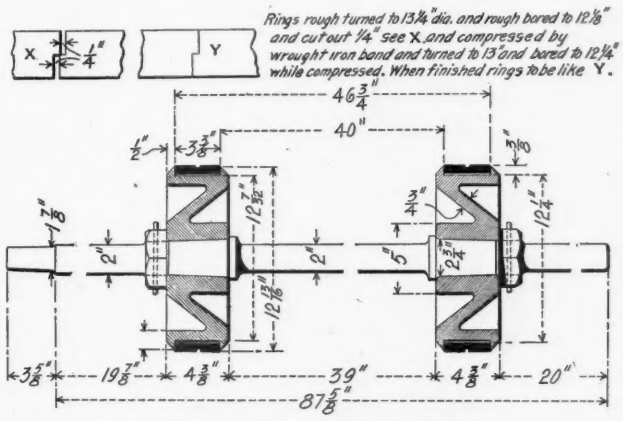
The piston valves have 1⅛-in. steam lap inside and ½-in. exhaust lap outside, the greatest travel being 7 in., and the valve being set ⅛ in. blind in full gear. It is evident from these proportions and the manner of setting the valves that the exhaust is purposely much delayed over that of ordinary exhaust action, and that the unusually long travel will compensate in the desired measure in the matter of port opening. The valve movement is so timed that the piston travels the full length of the stroke, and opens the central exhaust port in the cylinder before exhaust occurs through the piston valve passages, at long cut-offs. The exhaust from the central cylinder ports passes up through the center of the annular exhaust nozzle, which is shown among the illustrations, and the portion of the exhaust that passes the outer edge of the piston valve, in secondary action in long cut-offs, escapes through the annulus or outer ring of the exhaust nozzle tip. There is no complete tabulation of this valve movement available at this time, but we learn from the builders that at 5-in. cut-off the lead opening of the piston valve is 7-32 in. with a port opening of 9-32 in. It is evident that while the valve may be so set as to insure the opening of the cylinder exhaust first, and thus make the exhaust past the lip of the valve secondary at long cut-off, yet in the hooking back of the engine to short cut-offs there must come a point where this order will be reversed and the exhaust of the valve will be first and the exhaust through the central cylinder port will become the secondary action. Of this feature it is said that with the 5-in. cut-off it has been found that the exhaust action of the piston valve begins when the engine piston is about 3½ in. away from the opening of the central cylinder exhaust port. It is evident therefore that the reversing of the order of the exhaust action occurs somewhere in the neighborhood of 6-in. cut-off.

Among the several views of the exhaust nozzle that are given it may be seen that there are four distinct exhaust openings at the base of the nozzle. Two of these openings discharge the exhausts from the ports at the middle of the cylinder, and two of them are for the exhausts from the valve chambers. The four openings are merged into the final opening at the exhaust nozzle tip, as shown in the vertical sections and in the cross sections E F and C D. The final draft action is similar to that of a vortex nozzle. It is stated by the inventors of this cylinder that the exhaust pressure is not only reduced as low as atmospheric pressure, but that for a part of the stroke a partial vacuum is formed in the exhausting end of the cylinder.

It is to be regretted that no indicator cards from these engines are at hand, but we are informed that a thorough efficiency test will soon be made, and that indicator cards will then be taken. It is maintained that the diversion of the main volume of the exhaust from the live steam passages reduces the amount of cylinder condensation; also that there is extremely little dripping of condensation from the cylinders, presumably because the sudden and complete release of pressure in the cylinders at the end of the stroke causes a certain measure of re-evaporation at atmospheric pressure. That the net cylinder power of these engines, for a given initial volume of steam, is greater than the power obtainable from ordinary cylinder and valve arrangement cannot be doubted. It is likewise certain that the draft arrangements of the front end must be adapted to the different character of exhaust that is obtained. From investigations we have made with an exhaust of somewhat similar nature, but obtained by entirely different means, it is safe to say that the draft problem with this cylinder arrangement offers no great difficulty in satisfactory adjustment. The matter is said to have been very easily arranged in the Intercolonial locomotives, and we are informed that they are steaming as well as could be desired.



Rocker-Arm and Bushing—Intercolonial Locomotive.



Valve of Intercolonial Locomotive.

The passenger locomotive here illustrated was run at 70 miles an hour in recent road tests. A spectator who was on the engine during one such trial says the cylinder action was good and apparently free, and in that respect the speed could have been increased indefinitely, judging by outward indications.

Improvement of locomotives in regard to exhaust, compression, cylinder clearance and cylinder condensation is a subject that always holds interest, and the results of efficiency tests of these locomotives will give welcome information. The prime question would seem to be whether the economy of power that is claimed will be found to justify the use and maintenance of the additional cylinder length, and on this point it would be idle to speculate in advance of the tests.

The general specifications are given herewith:

General Specifications.

Description.	
Type	Ten-wheel passenger
Name of builder	Dickson Locomotive Works
Name of operating road	Intercolonial
Gage	4 ft. 8½ in.
Simple or compound	Simple
Kind of fuel to be used	Bituminous coal
Weight on drivers	124,000 lbs.
Weight on truck wheels	46,000 lbs.
Weight, total	170,000 lbs.
Weight, tender loaded	92,000 lbs.
General Dimensions.	
Wheel base, total, of engine	26 ft. 2 in.
Wheel base, driving	13 ft. 1 in.
Height, center of boiler above rails	110 9-16 in.
Height of stack above rails	15 ft.
Heating surface, fire-box	177 sq. ft.
Heating surface, tubes	2,023 sq ft.
Heating surface, total	2,200 sq. ft.
Grate area	30.75 sq. ft.
Wheels and Journals.	
Drivers, number	Six
Drivers, diameter	72 in.
Drivers, material of centers	Steeled cast iron
Truck wheels, diameter	33 in.
Journals, driving axle, size	8½ in. x 12 in.
Journals, truck axle, size	5½ in. x 12 in.
Main crank pin, Coffin steel	6½ in. x 6½ in.
Main side rod bearing	6¾ in. diam. x 5½ in.
Cylinders.	
Cylinders, diameter	20 in.
Piston, stroke	26 in.
Piston rod, diameter	4 in.
Kind of piston rod packing	United States
Main rod, length center to center	120 in.
Steam ports, width	1¾ in.
Valves.	
Valves	Piston; inside admiss.
Valves, greatest travel	7 in.
Valves, steam lap	1⅛ in.
Valves, exhaust lap	½ in.
Valves, lead in full gear	Blind ⅛ in.
Boiler.	
Type	Extended wagon-top
Working Steam pressure	200 lbs.
Thickness of steel in barrel	⅝ in. and 9-16 in.
Diameter of barrel inside smallest ring	60 in.
Seams, horizontal	Butt joint; welt strips
Seams, circumferential	Double riveted
Thickness of tube sheets	Front 9-16 in.; back ½ in.
Thickness of crown sheet	⅝ in.
Crown sheet stayed with	Radial and sling stays
Dome, diameter	Inside 30 in.
Fire-Box.	
Fire-box, length	108 in.
Fire-box, width	41 in.
Fire-box, depth front	71⅝ in.
Fire-box, depth, back	63¾ in.
Fire-box, material	Fire-box steel
Fire-box, thickness of sheets	Sides and back ⅝ in.
Fire-box, brick arch?	Yes
Fire-box, water space.	Front, 4 in.; sides, 3½ in.; back, 3½ in.
Grate, kind of	Rocking; two sections
Tubes.	
Tubes, number	276
Tubes, material	Shelby steel No. 12
Tubes, outside diameter	2 in.
Tubes, length over sheets	14 ft.
Smoke-box.	
Smoke-box, diameter	64⅛ in.
Smoke-box, length	70½ in.
Other Parts.	
Exhaust nozzle, annular	Permanent
Exhaust nozzle, diameter of tip	5½ in.
Exhaust nozzle, distance of tip below center of boiler	2 in.
Stack, straight	Diameter 17½ in.
Stack, height above smoke-box	37½ in.
Tender.	
Type	Swivel trucks
Tank capacity for water	4,200 gallons
Coal capacity	6 tons
Type of under-frame	Steel channels
Type of truck	Shickle, Harrison & Howard
Truck wheels	36 in.; plate; Mansell rings
Diameter and length of axle journals	4¼ x 8 in.
Type of truck bolster	Cast steel
Type of truck transom	Cast steel
Special Equipment.	
Wheel centers	Steeled cast iron
Axles	Midvale steel
Sight-feed lubricators	Nathan, triple, No. 9
Front and back couplers	Janney
Safety valves	Two 3 in., Star brass
Steam heat equipment	Consolidated
Injectors	Two No. 9 Hancock inspirators
Driver brake equipment	Westinghouse
Tender brake equipment	Westinghouse
Tender brake-beam	Sterlingworth

The Basis of Engine Rating.

BY J. SHIRLEY EATON.

How can locomotive tonnage rating be put into effect on a road? A General Superintendent writes: "It is a very simple matter. Find out what your engines can haul, and then see that they haul it." Now, this can be done in all manner of ways, from the so-called "practical" method to the elaborately theoretical. By the "practical" method we find the worst hill on each run, where there may not be a helper and successively test each locomotive to see how many loaded cars and empties, rated in their equivalent of loads, it can pull over that hill. The resistance is in units of loaded cars which we can use in measuring any train over that particular hill. The power is in no unit applicable to any other locomotive than the one actually tried. In other words, the test is of no value except when the same conditions are in combination in the same way. It has developed no formulae that are applicable at other places and under other conditions than at the specific place where the test was made. A road would have to have as many such tests as there were road engines multiplied by the number of ruling grades, and at best the results would be inaccurate. The engine would be in different condition, the rail would be better or worse at times, the cars would be big or little and full or light loaded, one Trainmaster would rate his engines up to their limit or the next would rate them low, etc., etc. Yet this sort of tonnage rating up to almost the present decade was accepted as sufficient. Mr. W. G. Berg, Chief Engineer of the L. V. R. R., describes this as the first of the three stages by which the most advanced practice of tonnage rating has come about.

Most roads have long since passed to the second stage. The work or resistance is no longer taken in the indefinite unit of loaded cars hauled, but in gross tons hauled, which is a unit of far more general application and accuracy. Only one engine of each class is tested. Its test is good for all of its class. This is a definite movement along scientific lines, substituting for a great number of simple formulae of very limited application a small number of complex formulae for a great variety of conditions. Up to this stage the dynamometer car has not been really necessary, for we began with runs already determined, and ruling grades already located, and we make a test for each ruling grade. We are not able to make a test on one ruling grade apply on a different ruling grade, because resistance has not been stated in sufficiently general terms.

Mr. Berg's third stage in tonnage rating is now being developed by the more advanced roads. On the one hand the endeavor is to have the power stated in some unit of power which we can begin with in the drafting room, where we design the locomotive. On the other hand, the resistance is to be stated in such units that, if given, the data of grade, curve, speed, temperature, etc., we may for *any time* and *any place* work out the resistance. Many of the elements of the problem are not yet worked out to generally accepted formulae. But the chief difficulty is to determine just how far it is profitable to go in the application of formulae already had, when the data for which they are to be used must, under working conditions, be more or less inaccurate.

The starting point is the pounds of steam pressure carried in the boiler. We must use a series of coefficients that will carry us successively through all the links of the chain to cylinder mean effective pressure, at various piston speeds, to train speed, to cylinder horse-power, to tractive power at the rail to drawbar pull behind the tender, which is the point where the locomotive begins for the transportation officer.

Among the first efforts to practically measure the efficiency of its power may be mentioned that of the Great Northern. They did not use a dynamometer car, but loading the engine to its maximum they turned actual weight and grade and curve resistance into drawbar pull by formula of $(7 + 20\ g + \frac{1}{2}\ c)$ lbs. per ton. In this formula 7 lbs. was rolling friction, g was per cent. of grade and c was degree of curve. Efficiencies thus determined on one grade, they were worked out for other grades by dividing by the theoretical resistance. But there was an acknowledged margin of possible error here of 9.5 per cent. A large number of roads now have come to use the dynamometer car. By this, on the one hand, they are able to measure the practical efficiency of their power in accurate units which can be applied against resistance units at any other time and place, and on the other hand to measure resistance in accurate units at specific places, or to measure special conditions which they desire to reduce to formulae. Most roads at present reckon their power in drawbar pull, but others, and notably the Southern Pacific, state it in pounds of tractive effort at the rail.

The Southern Pacific, one of the very foremost roads in tonnage rating, starts with a chart on which is plotted a curve showing mean effective pressures in per cent. of boiler pressure at various piston speeds. This pressure is carried to train speed by the formula for their standard engine $S = \frac{56\ X\ L}{D}$ in which

S = piston speed in feet per minute
X = train speed in miles per hour
D = diameter of driver in inches
L = length of piston stroke.

As their unit of power they take that cylinder capacity which at 10 miles per hour will develop a tractive power at the rail of 1,000 lbs. By the formula $\frac{(d^2 - d_1^2)}{\frac{2}{D}}\ L\ P$ in which

d = diameter of piston
d_1 = diameter of piston rod
L = length of stroke in inches
P = mean effective pressure
D = diameter of drivers,

they carry the mean effective pressure (at piston speed corresponding to given train speed) to tractive power at rail. On their standard engine $\frac{L}{D}$ equals $\frac{26}{55}$ (piston stroke in inches divided by diameter of wheel in inches). Every other engine or group of engines is related to the standard engine by the coefficient of its $\frac{L}{D}$ to $\frac{26}{55}$ and the formulae evolved for the standard engine are extended to engines of other classes by inserting this coefficient for each class. The adhesion assumed throughout is 25 per cent., which is a little higher than usually counted on. This is the factor which must be subject to constant adjustments for weather conditions. Some roads make a regular allowance for night runs when the rail will be normally more moist.

There yet remains the very important but necessarily indefinite factor of condition of power. It is generally left to the motive power department, who are responsible for the charge, to make specific allowances in per cent., for off-type power, and the normal rating is adjusted by this coefficient.

Some types of engines lose less draft power at high speeds than others. The requirements call for a certain margin within which the engine can adjust itself to the irregularities of grade work to be performed by compensating in the speed. Where this is a wide margin we want to select the engines that suffer least loss of efficiency at high speeds. On short grades in an undulating territory we want to "chunk" the hills at high speed.

For a country with long continuous grades we want a coefficient of boiler power to cylinder power requirements that would be excessive for level country and shorter grades.

Power is the one major factor to the problem, and resistance is the other. Resistance, perhaps, is the more difficult and the less understood. In finding out resistance in the simpler forms of train rating we go direct to the ruling grade or stalling point and nowhere else. Then we find the drawbar pull per ton of weight, and this divided into the power of the engine gives the rating for the run. The stalling point is not necessarily the heaviest grade. It may be the grade with a station or block signal at its foot. A dynamometer car is generally used, but when not available the gross tons hauled are used. These are extended to equivalent resistance by formulae for grade, curve, rolling and axle friction and speed resistance. Such results, however, are exposed to a considerable margin of variation by reason of factors omitted, which in some situations may have considerable significance.

The next stage is to determine the resistance for all sections of the run at all speeds. This may be done by dynamometer car or by computation from data already at hand. We now have the resistance of each section over the run, but there is a large number of conditions which are special to each particular train. Most of these, in any practical scheme of tonnage rating, must be assumed to belong to general average conditions. It has been found in practice that their individual variations largely offset one another, and a general coefficient can sometimes be made applicable over a certain territory to roughly cover them.

But the variation of resistance per ton of load according to concentration of load can no longer be ignored. It becomes a special factor on level roads with heavy curvature and long trains offering long friction base. Sometimes a direct allowance of 5 tons constructive weight is added to actual gross weight of each car and lading. But generally a table or chart of allowances is compiled based on a curve which shows an increase of resistance per ton for empty cars over loaded, reaching 33 per cent. at the maximum.

Having now determined power and resistance over the run, we begin with an assumed minimum speed over the ruling grade. At that speed the power is loaded to its limit. If the load over the entire run is about the same we have a margin of unused power over the lighter grades and levels which we may absorb by speed.

This in outline is the method of setting up a tonnage rating system for individual engines. It leads to the larger field of skill in so disposing the aggregate of power as to accomplish a very irregular volume of work at a minimum of loss of potential. The general problem is to fit a fairly constant rate of power to a varying rate of work to be done, so that there shall be least loss. If we trace out this work to be done, graphically by a curve, it makes a very jagged line. Into all its unevenness must be fitted the power with as little loss by surplus as possible. The jagged line began with the curve, sags and hogbacks, the constructing engineer left behind him. Stations, crossings and block signals threw in more angles. Traffic conditions threw a balance of conditions one way and broke the line yet more. The first step in smoothing out the line is to turn curves into their equivalents of grade resistance on the profile of the road. Then on this as the base line to plot the velocity heads taken at frequent intervals on an engine, under rated load, working up to its maximum and stopped at all stations and stopping places. Connecting these points thus plotted, we have a new grade line representing actual work and called the virtual grade.

By adjusting the speed, by doubling, by helpers, by turning back part of the power, we manage to hold down the wasted efficiency of power to the minimum. The changes in balance and density of traffic, weather conditions and condition of power may be so great as to constantly jeopardize the margins in any arrangement we may make. We have before us a great game of combinations requiring the highest order of skill.

Having scheduled our individual engines and scheduled the disposition of all our power and devised formulae for shifting conditions, we now want a simple plan of applying the ratings and holding the service up to the standard laid out. Engines are grouped into classes by a key furnished the yardmasters. Each class is rated for each run in gross tons, and an allowance made for speed. A normal coefficient of tare to net weight per car is assumed, and a table of additions or deductions of constructive tonnage, to adjust for variation of resistance by light or heavy loading, is prepared and furnished for each run because the ruling grades may be different.

The yardmaster works under rigid rules which may only be modified by authority of the Despatcher or Trainmaster, who must assume full responsibility for such modifications. Thus allowances for weather or condition of power should be authorized only by them or the Superintendent. The weather conditions are those which govern at the ruling grade. The yardmaster keeps a memorandum of gross tons and rated tons of all trains leaving the yard. The Trainmaster or Despatcher keeps a similar log of all trains leaving terminals in which he jots down an explanation for all lost mileage by underloading. He gets a daily statement from the car accountant of rated ton-mileage and actual ton-mileage. To account for the discrepancy he must tabulate from his log the ton-mileage lost under the appropriate headings of explanation. Thus, beginning with the yardmaster and working forward through the hands of all parties responsible up to the general operating officer, are passed the figures of performance which make the men's records of efficiency. This constitutes a powerful stimulus. Tonnage rating is no longer a mere experiment. It must be applied specifically for each road. No general rules can hold inflexible for all the conditions. Roads with dense traffic will require a large margin of potential to be used as speed in picking up a train and getting out of the way of scheduled trains. A large number of crossings, stations, slow downs or block signals make it necessary that the engine carry a margin of power for the accelerations which these stops require. Roads with long grades cannot use the velocity grade to much advantage. In general, roads of sparse traffic, offering a large margin of unused track capacity with stopping places subordinate to grades, can work their power down to a narrow margin of reserve. On the other hand, roads with dense traffic offering a small margin of unused track capacity must carry a wide margin of reserve efficiency on the locomotive. As summarized very aptly by Mr. Berg:

"Investigation on scientific line based on dynamometer tests supplemented by discriminating intelligent analysis by practical railroad men, acquainted with the conditions under investigation, must precede any final working plan or resulting table of ratings. While it is desirable to analyze each integral element entering into the problem with all the accuracy and nicety possible, glittering generalities and apparently sound and interesting mathematical deductions must not be accepted as offering the much desired solution. The main aim must not be lost sight of that the rules or tables to be established must fall within the intellectual scope of men filling the position of yard masters and yard clerks. They are the ones who primarily apply these rules. The mathematical and critical analytical investigations, however, cannot be dispensed with. They establish the vital component factors affecting the question. The day is past when the so-called practical railroader can decry the modern system of tonnage rating as a fad of the times. Closer profit margins are rapidly forcing railroad administration to a science. Results are severely scrutinized by comparative and analytical statistical methods as never before. Railroad officials rise or fall by results accomplished. The key in a large measure to the operating efficiency of a road to-day is the tonnage hauled for each potential unit of power furnished."

The problem, as stated by the General Superintendent, "Find out what your engines can haul and then see that they haul it," is still the same, but the methods of its solution to-day are more exact and conclusive because rules of thumb are giving way to carefully evolved formulae of practice.

Erie Class H-12 Consolidation Locomotive.

Last September the Brooks Locomotive Works delivered to the Erie Railroad 25 consolidation locomotives which are classified as H-12, and have given so much satisfaction that the design has practically been duplicated in 15 consolidation engines, which will be classified as H-13, and are now being built by the Baldwin Locomotive Works. The Class H-13 engines will differ only in those slight modifications which are necessary to adapt some Baldwin patterns and practice to the design which was used at the Brooks Works in building the H-12 engines. It may be noted that the Class H-12 engines which are here illustrated are heavy, and that a large proportion of the weight is on the driving wheels; also that the height from rail to the center of the boiler is 119 in., this being, as far as we have any record, the greatest height from rail to center of boiler that has yet been used. The engines have the wide fire-box above the frames, and will burn a mixture of bird's-eye anthracite and bituminous culm. They are working on the Allegheny, Jefferson and Bradford divisions, in heavy freight service.

The cylinders are 21 in. x 28 in., the driving wheels are 63 in. in diam. over tires, and the wheel centers are cast steel. The engine truck wheels are 30 in. in diam., and have journals 5½ in. x 10 in. The journals of driving axles are 8½ in. and 9½ in. x 12 in., and the main crank pin is 7 in. in diam. The main rod is 11 ft. 10 in. from center to center, and the steam ports are 19 in. long x 1⅝ in. wide; exhaust ports 19 in. long, 3 in. wide, and the bridge width 1½ in. The driving wheel base is 17 ft., the total wheel base of engine 25 ft. 3 in., and the total wheel base of engine and tender 51 ft. 4½ in. The height of stack above rail is 15 ft. 5 in.

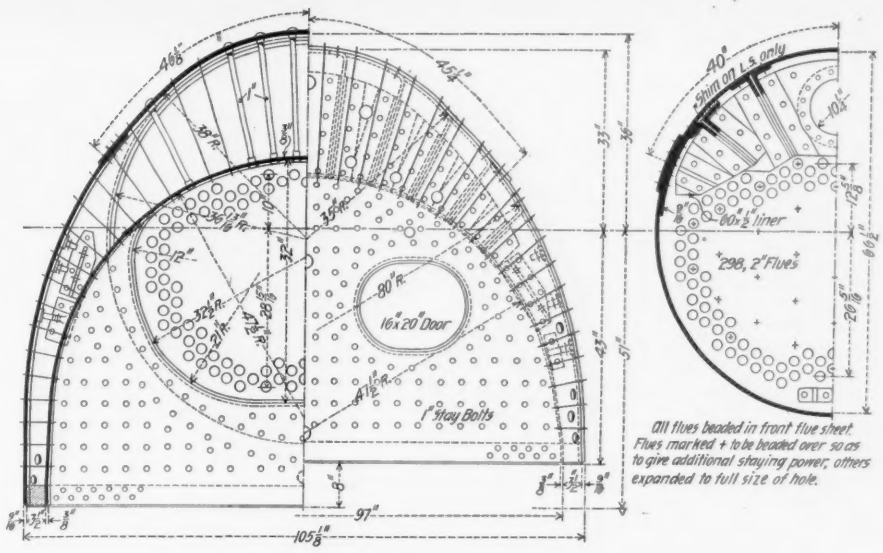
The total weight of engine is 189,400 lbs., 165,900 lbs. of which is on the drivers and 23,500 lbs. on the engine truck. The tender loaded weighs 126,400 lbs. There is a total of 2,391 sq. ft. of heating surface, 2,224 sq. ft. of which is in the tubes and 167 sq. ft. in the fire-box. There are 298 tubes 2 in. outside diam., 13 ft. 2¼ in. long over flue sheets. The grate area is 75 sq. ft. The boiler is straight, with Wootten fire-box, and carries 200 lbs. working steam pressure. The barrel of the boiler is carbon steel 68 in. diam. and 13-16 in. thick, the horizontal seams being sextuple riveted and the circumferential seams double riveted. The thickness of tube sheets is ⅝ in. back and ¾ in. front, the crown sheet being ⅜ in. thick and stayed with radial stays. The outside diameter of the dome is 31¼ in.

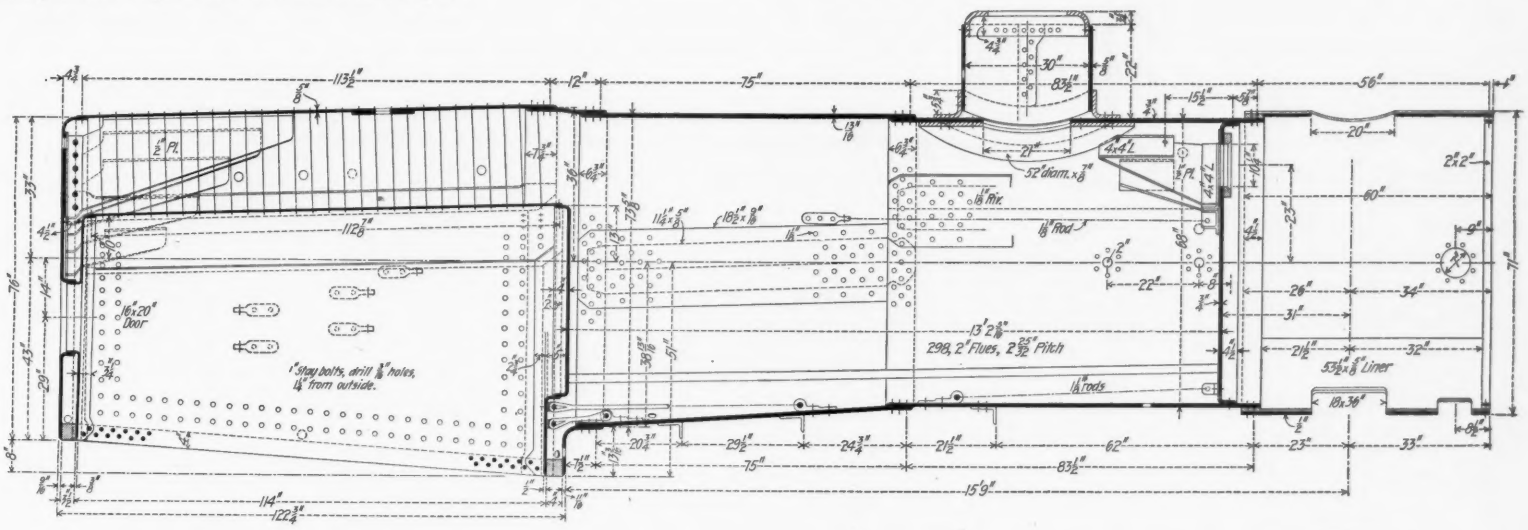
The fire-box is 113 in. long, 96 in. wide, 64 in. deep at front and 53 in. deep at back, the material being carbon steel ½ in. thick in the front sheet and ⅜ in. back sheet. The sides are 5-16 in. thick, and the water space is 4 in. at front, 3½ in. at sides and 3½ in. at back. Rocking grates are used and no brick arch. The smoke-box is 65 in. long and 71 in. in diam., and the exhaust nozzle is single and permanent, 5 in. diam., the tip of the nozzle being at the height of the center line of the boiler. American balanced valves are used, the greatest travel of which is 6 in., the outside lap 1 in., the lead in full gear 1-32 in., and the exhaust edges of the valve being line and line. The stack is tapered, the

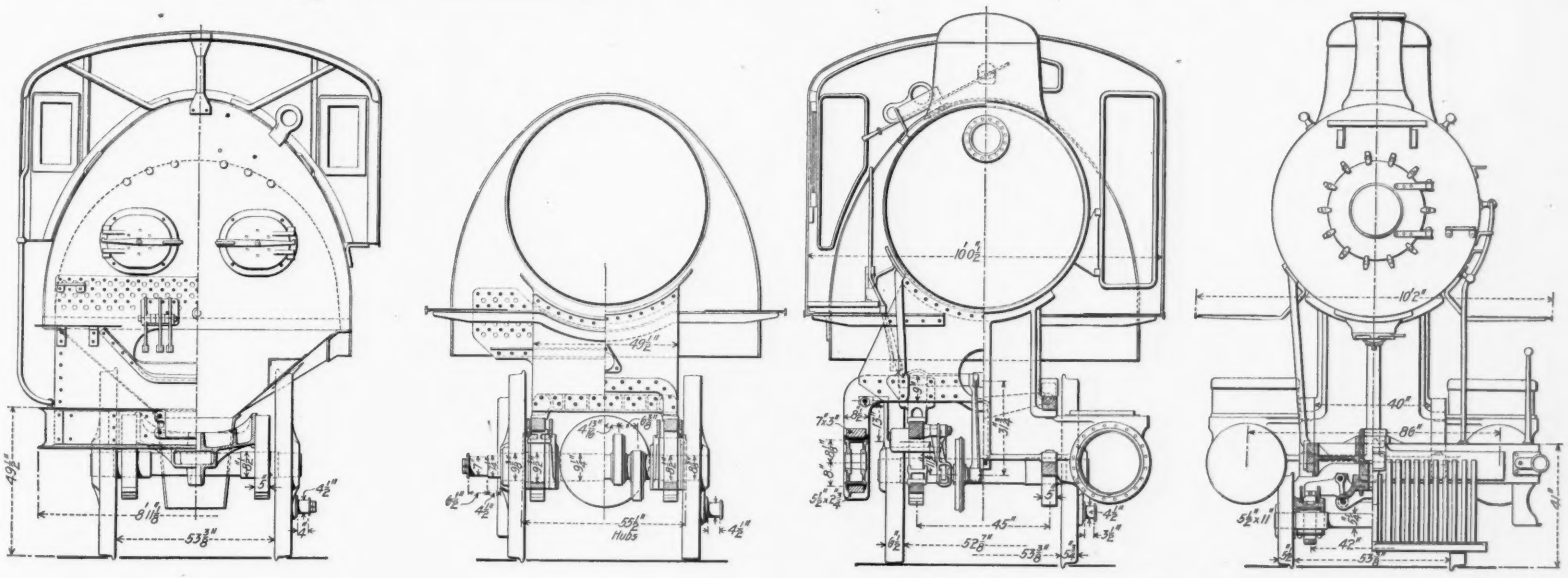
greatest diameter being 16 in. and the least diameter 14⅜ in. with a height of 30⅜ in. above the smoke-box.

The tender has a steel underframe and two four-wheeled Fox trucks, the diameter of the truck wheels being 36 in. Elliptic and spiral springs are used with floating steel bolsters, and steel truck transoms. The length of the tank is 22 ft. and length of tender frame over bumpers 25 ft. 7 in. The width of tank inside is 116 in. and the height, not including collar, 62½ in. The capacity is 6,000 gals. of water and 14 tons of coal. No water scoop is used.

The wheel centers of these engines were made by the American Steel Casting Co. and tires by the Midvale Steel Co. The driving axles are steel, made to specifications. The front and back couplers are Gould. Three Consolidated 3-in. safety valves are used. There are Detroit triple sight-feed lubricators, Gollmar bell ringers, Leach sanding devices, two No. 10 Metropolitan injectors, Westinghouse-American driver brake equipment, and Westinghouse brakes for tender and train. The tender brake-beams are Kewanee. A 9½-in. Westinghouse air pump, and Westinghouse governor is used. The steam gages are Ashcroft. All springs were made by the A. French Spring Co. Piston rod and valve stem packings are U. S. Metallic. Taylor staybolt iron is used, and the engines have the Erie standard pilot.


16"x20" Door
1" Stay Bolts
298, 2" Flues
All flues beaded in front flue sheet. Flues marked + to be beaded over so as to give additional staying power; others expanded to full size of hole.





Erie Class H-12 Simple Consolidation Locomotive.

Built by the BROOKS LOCOMOTIVE WORKS, *Dunkirk, N. Y.* *Designed by* MR. ALBERT E. MITCHELL, *Supt. of Motive Power.*

Saving in Fuel Consumption by the Compound Locomotive.

BY C. J. MELLIN, *Chief Engineer Richmond Locomotive Works.*

Ever since the steam engine became a practical motor the reduction in fuel consumption has been a never ending object of designers of such engines in all their forms and purposes. Comparatively early in its existence, the double expansion principle (commonly called compound) was recognized as the most efficient method by which a reduction in fuel consumption could be effected in marine engines, even at a boiler pressure of 25 lbs. to the square inch. With the gradual increase of pressure (made possible by the improvement in the art of boiler construction) the saving became greater in proportion, and a reduction from 6 lbs. of coal per horse power of the earlier single expansion engine to 2 lbs. on the double expansion plan was accomplished at a boiler pressure of 75 lbs. to the square inch. At this point the celebrated Scotch engineer, Dr. C. A. Kirk, one of the two partners of the firm of R. Napier & Son, Glasgow, Scotland, with whom the writer had the good fortune to be a pupil back in the '70s, conceived the idea of adding a third stage to the expansion of steam. This idea was carried into effect in the application of a set of triple expansion engines to the S. S. "Aberdeen," which as is a well known fact, proved to be a decided success, and a general adoption of the triple expansion principle was at once started in every country on the globe engaged in engineering pursuits, without a dissenting voice.

The fierce opposition encountered in the introduction of the compound principle met its Waterloo in the signal success of the compound engine, and the triple and quadruple expansion types have had their free and open way, which has made possible the rapid progress and excellent performances recorded both in the navy and merchant marine, of which the latest Atlantic racers give decisive examples. Stationary engineers have followed the lead of their brother marine engineers with equal success, and a record of even less than one pound of coal per hourse power per hour has been made.

The locomotive engine has been lagging behind somewhat in comparative efficiency, although there is no reason why it should not, with proper co-operation, advance along the same lines, as it has the advantage of higher steam pressure in its favor over most of the other kind of engines. The actual causes for the tardy progress of the double expansion principle in railroad service have been effectually removed, and its advantages considerably improved upon since its early appearance, which renders the compound locomotive a superior railroad motor to the simple engine (see *Railroad Gazette*, Jan. 25, 1901, page 60), and this step has followed the same general rule that has governed the progress made in the marine and stationary lines. These facts have not as yet received the acknowledgment and recognition they deserve, but with a more general knowledge of the merits of the compound in its present advanced condition it will rapidly come to the front.

A saving of from 15 per cent. to 25 per cent. in fuel has been clearly and completely demonstrated by carefully conducted scientific tests and by years of comparative service tests on different railroads, from which the following collection of results has been obtained. All these records have been supplied by railroad officials who have compounds in their service, and may, therefore, be considered impartial. The figures show that the average per cent. in saving is far above the average claimed. With the numerous records and reports of performances from different points of the country at hand, it is safe to say that where the saving falls under the 15 per cent. mark the cause of such shortcomings is to be found in conditions not chargeable to the compound principle.

The Further Development of Cast Iron Wheels.

BY S. P. BUSH.

The possible deficiency of the cast iron wheel which has been suggested in the columns of the *Railroad Gazette* is a matter of more than ordinary interest both to the railroads and wheel makers. From what has been said, it appears as if the difficulty lies in the breakage of flanges, and as it has been observed more frequently in the case of 50-ton cars, it would not be unnatural to conclude that the service is too severe.

The cast iron wheel is in many respects ideal in its make up. It has a very hard, durable tread, a tough body or center, is composed of but a single piece, is cheap, and can be made in many parts of the country. It has rendered such valuable service, and has been the source of such great economy that it would seem that if some assistance could be rendered it, or if some further development could be made upon it, it would certainly be to the advantage of the railroads to do so. It has been thoroughly demonstrated up to the present time at least that any other kind of wheel service would increase the cost from four to five times, but, even if it were but double, it would be enough to warrant a much greater outlay in the cast iron wheel than is the usual practice.

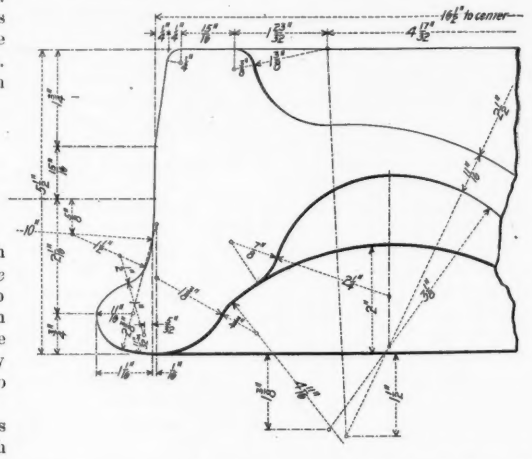
Assuming that the principal difficulty lies in the breakage of flanges, it appears to the writer that there may be a remedy in the direction of relieving the flange of some of the work that it has sometimes to perform. In designing the 80,000 and 100,000 lbs. capacity M. C. B. axles, an allowance of 40 per cent. was made in the strength in order to resist the lateral thrust which is transmitted through the wheel flange to the axle. It may be assumed that this thrust may be taken somewhat as a blow rather than as a pressure covering a time interval, which assumption is undoubtedly fair under the conditions brought about by the use of a rigid truck. It may be that, even with a rigid truck, the lateral force does not reach quite the intensity of a blow, but it is safe to say that it must more nearly approach such than is the case with trucks permitting lateral motion, and more of a time interval through which to receive the force. This is readily demonstrated. Surely we could not use passenger cars to-day with rigid trucks. They would not be tolerated. Is it right, therefore, to expect the flange of a cast iron wheel to perform such work when it is known that it can easily be knocked off with a small sledge in the hands of the ordinary man? The stiffening of the axle and the more rigid construction of the 100,000 lbs. capacity steel car have but added to the already difficult work of the flange.

Certainly it seems that much may be accomplished by so constructing cars that the lateral forces which the flange is called upon to receive will be cushioned more or less. This would not only prove a benefit to the wheel but to the axle, and the whole structure of the car, to say nothing of the track.

It is believed by the writer that the life of the flange and wheel could be materially improved by abandoning the present custom. The standard contour of the country is conical tread. What takes place when a new wheel carrying 17,000 lbs. rests on the top of a rail head is clear. Theoretically, the bearing is a point, but as a matter of fact the wheel is forced into the rail to the detriment of the latter, and the rapid wear of the former over that portion of the tread which comes in contact with rail, until the tread is worn to a natural contour nearly flat or cylindrical for approximately 1¾ in. of the width, about as shown by the diagram.

It frequently happens, however, that this cylindrical portion commences very close to the flange as a result of some influence constantly forcing the flange against the rail, which might be easily avoided, however, by having the contour as shown by the diagram at the start. This contour protects the flange in a most admirable manner, inasmuch as that portion of the tread between the cylindrical portion and the flange presents a rapidly increasing diameter of wheel which will check any tendency toward flange wear or pressure. This contour is in effect the "Barr" contour, and the writer can state from experience that it is thoroughly satisfactory. It certainly appeals to the judgment as logical and practical.

We know beyond question that any contour must come



Contour of Wheel Tread for 33-Inch Wheel.—S. P. Bush.

TABLE SHOWING RESULTS IN SAVING BY THE COMPOUND LOCOMOTIVE, COLLECTED FROM VARIOUS RECORDS OF PERFORMANCES IN REGULAR SERVICE AND ROAD TESTS.

Reference No.	Duration of Test.	Coal Consumed on Equal Units. Simple.	Coal Consumed on Equal Units. Compound.	Per Cent. Saving in Favor of Compound.	Water Consumed on Equal Units. Simple.	Water Consumed on Equal Units. Compound.	Per Cent. Saving in Favor of Compound.	Repairs. Simple.	Repairs. Compound.	Repairs. Per Cent. in Favor of Simple.	Repairs. Per Cent. in Favor of Compound.	Boiler Pressure Simple.	Boiler Pressure Compound.	
1	½ month	3.42	2.60	23.97	.....	.....	.....	.....	.....	.....	.....	160	160	1 Simple and 1 Compound, 1893.
2	1 year	5.02	3.71	26.10	.....	.....	.....	2.27	1.61	.....	29.07	160	160	10 " " 1 " 1893.
3	2 years	3.91	2.95	24.5	.....	.....	.....	3.13	2.88	.....	7.10	160	160	10 " " 1 " 1894.
4	3 months	7.46	4.72	36.70	.....	.....	.....	3.93	1.20	.....	62.80	160	160	5 " " 1 " 1900.
5	1 year	4.64	3.50	24.6	.....	.....	.....	.....	.....	.....	.....	180	180	10 " " 2 " 1897.
6	9 months	4.80	3.70	22.9	.....	.....	.....	4.09	3.90	.....	5.00	180	180	10 " " 2 " 1896.
7	2 "	2.66	1.99	25.19	16.09	13.15	18.26	.....	.....	.....	.....	180	200	1 " " 1 " 1895.
8	3 "	150.41	121.22	19.4	.....	.....	.....	2.1	1.5	.....	28.6	180	190	5 " " 5 " 1896.
9	½ month	3.44	2.24	34.96	.....	.....	.....	.....	.....	.....	.....	136	190	1 " " 1 " 1895.
10	½ "	88.99	71.3	19.9	.....	.....	.....	.....	.....	.....	.....	156	154	1 " " 1 " 1896.
11	2 months	.24	.16	33.33	13 09	10.96	16.27	.....	.....	.....	.....	180	200	1 " " 1 " 1897.
12	1½ years	.....	.....	20.34	.....	.....	.....	1.26	1.55	22	.....	180	200	4 " " 3 " 1900.
13	½ month	10.99	8.99	17.33	.....	.....	.....	.....	.....	.....	.....	180	200	1 " " 1 " 1895.
14	1 "	.2234	.1818	23 14	1.45	1.185	18.27	.....	.....	.....	...	210	200	1 " " 1 " 1899.
15	9 months	6.16	4.86	21.1	.....	.....	.....	.....	.....	.....	.....	200	200	10 " " 5 " 1899.
16	½ month	2.90	1 97	32.0	.....	.....	.....	.....	.....	.....	.....	180	200	1 " " 1 " 1898.
17	.....	9.41	6.6	35.5	.....	.....	.....	.....	.....	.....	.....	135	175	*Railroad Gazette*—3-3-1893.
18	.....	4.53	3.2	29.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " 4-28-1893.
19	.....	5.52	3.92	29.3	.....	.....	.....	.....	.....	.....	.....	180	180	" " 10-12-1894.
20	.....	19.41	12.59	35.1	.....	.....	.....	.....	.....	.....	.....	160	180	" " 4-13-1894.
21	.....	11.09	8.27	25.4	.....	.....	.....	.....	.....	.....	.....	180	200	" " 11-29-1895.
22	2 years	3 96	2.89	27.0	.....	.....	.....	.....	.....	.....	.....	180	180	" " 12-6-1895.
23	.....	3.33	2.49	25.23	16.09	13.15	13.32	.....	.....	.....	.....	180	180–200	" " 12-13-1895.
24	.....	11.35	8.63	24.17	104.38	86.64	18.91	.....	.....	.....	.....	180	180–200	" " 12-13-1895.
25	.....	14.97	12.65	18.03	.....	.....	.....	.....	.....	.....	.....	180	200	" " 1-28-1898.
26	.....	13.89	11.50	20.8	.....	.....	.....	.....	.....	.....	.....	180	200	" " 1-28-1898.
27	3 years	3.95	3.05	22.8	.....	.....	.....	.....	.....	.....	.....	160	160	*Railway Age*—7-31-1896.
28	.....	86.8	54.4	37.2	54.96	45.38	17.4	.....	.....	.....	.....	145	180	" " 2-2-1894.
29	4 years	4 69	3 69	21.3	.....	.....	.....	3.04	3.07	0.9	.....	160	160	M. M. Proceedings, 1897.
30	1 year	.....	.....	19 2	.....	.....	.....	.....	.....	.....	.....	165	200	" " 1897.
31	1 "	14.57	12.11	20.3	.....	.....	.....	.....	.....	.....	.....	180	200	" " 1897.
32	.....	.....	.....	18.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	*Railroad Gazette*—1-23-1893.
	Average Per Cent. Saving			25.2	.....	.....	17.9	.....	.....	.....	15.52	In Favor of Compound.		

References to the Above Table.

Test No. 1 On Chesapeake & Ohio R. R., year 1893, same class of engines.

Tests No. 2 to 4 inclusive are records between simple and compound engines on the Chesapeake & Ohio R. R. under long periods in same kind of service,

Tests No. 5 and 6 are similar records as above on C., C., C. & St. L. R. R.

Test No. 13 C., R. I. & P. report of service test.

Test No. 14 Service test on D. & R. G. R. R.

Test No. 15 Service test on Wabash.

Test No. 16 Service test on Fitchburg R. R.

Test No. 17 Service test of Baldwin compounds on C., N. O. & T. R. R.

Test No. 18 Service test of Baldwin compound on N. Y. C. & St. L. R. R.

Test No. 19 Service test on C., C., C. & St. L. R. R.

Test No. 20 Service test on Baldwin compound.

Test No. 21 Service test on C., R. I. & P. R. R.

Test No. 22 Service test on C., C., C. & St. L. R. R.

Test No. 23 Average of various test in freight service.

Test No. 24 Average of various tests in passenger service.

Test No. 25 and 26 Report of St. Louis Railway Club, average results of Baldwin compounds.

Tests No. 27 and 29 Service tests on Chesapeake & Ohio R. R.

Test No. 28 Service test on Long Island R. R., Baldwin compounds.

Test No. 30 Record of heavy hauling service on C. & O. R. R.

Test No. 31 Service on C., M. & St. P. R. R., Baldwin compounds.

Test No. 32 P. & N. W. report of Master Mechanics' Convention, 1893.

All except 17, 18, 20, 25, 26, 28, 31 and 32 are Richmond compounds.

Tests No. 7, 8, 11 and 12 are from service, but we are not permitted to give the names of the roads.

approximately to this after a very short service, and there seems to be no good reason why wheels should not have this to begin with and thus avoid many of the cases of early flange wear. Once a wheel is worn at the flange the possibility of failure is very much increased inasmuch as the pressure against the flange, instead of being at the root, where it is best able to resist, is farther away from the tread, and consequently increases the movement or leverage operating to force the flange off.

It is unnecessary to say that the quality of cast iron wheel must be the best, but aside from this it can be hardly doubted that there is an opportunity to help the cast iron wheel perform satisfactorily the greater work that has of late been imposed upon it.

West Milwaukee, June 6.

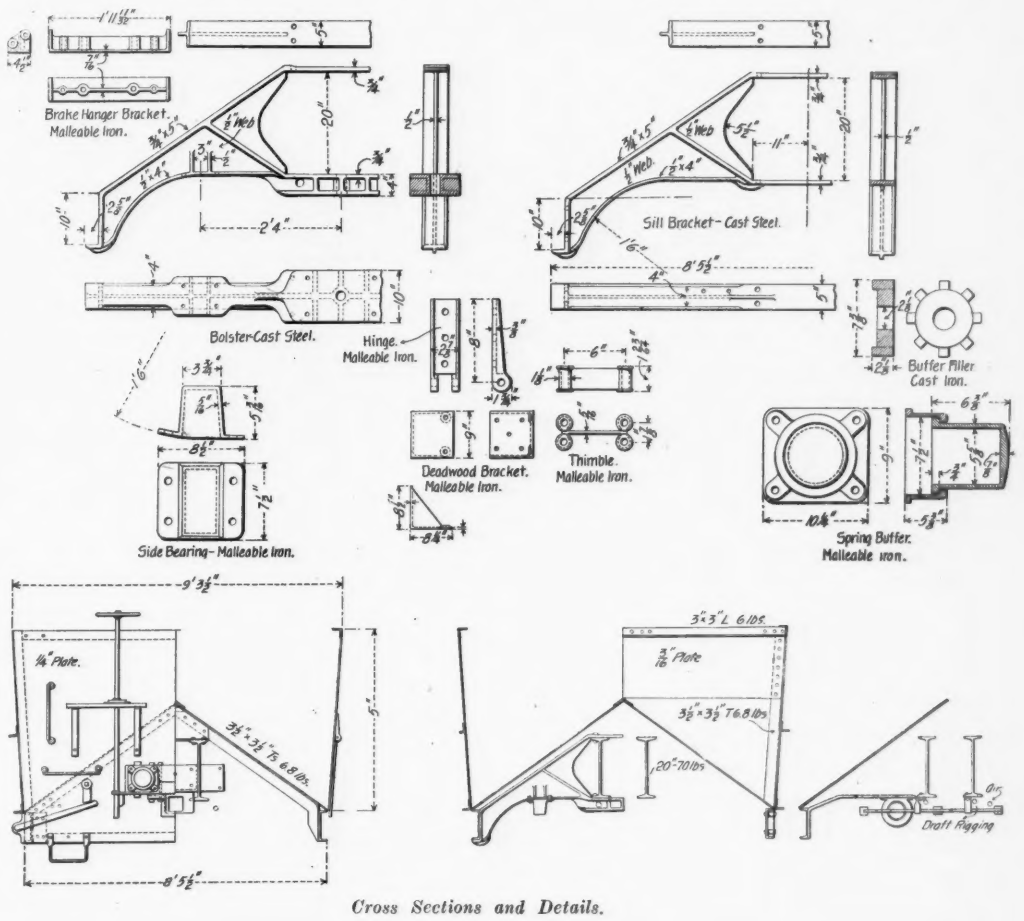
80,000-lbs. Capacity Steel Dump Car—Atchison, Topeka & Santa Fe.

Within the past year 10 steel dump cars were built at the Topeka shops of the Atchison, Topeka & Santa Fe from designs made under the direction of Mr. John Player, Superintendent of Machinery, who furnished the drawings and information from which this description is given. The cars have been in regular service hauling coal and ballast for several months, and they are satisfactory. Player cast steel trucks, as made by the Shickle, Harrison & Howard Iron Company, suitable for 80,000 lbs. capacity, are used. These trucks have been described in the *Railroad Gazette*, and our readers are familiar with the design. It is apparent from accompanying illustrations of the car that neither end sills nor intermediate sills are used, and that the side sills are single 10-in. channels weighing 15 lbs. per ft. The center sills are two 20-in. I-beams weighing 70 lbs. per ft. and serving also as continuous draft sills having no interruption in their total length. No diagonal sill braces and no truss rods are used. The floor, floor supports and the sills are riveted together, making a rigid and durable structure.

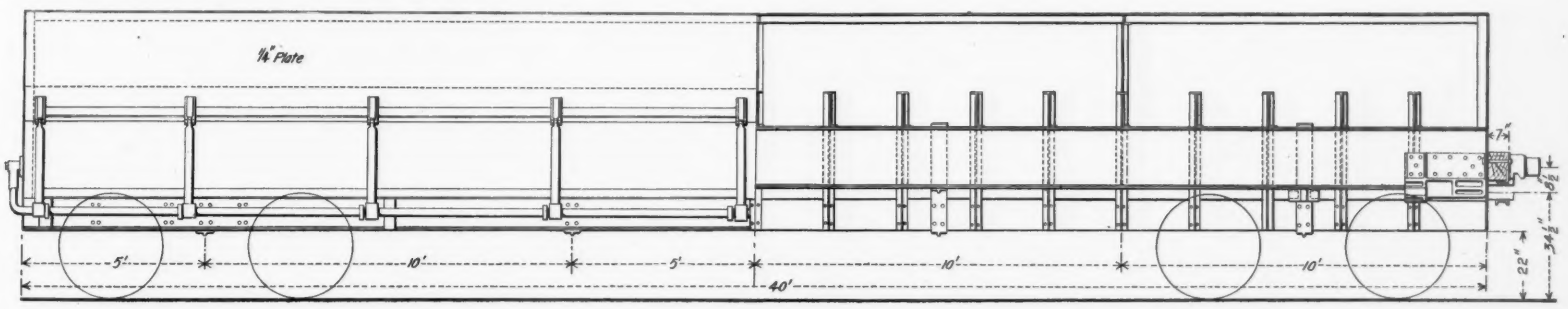
The clear length of car inside is 40 ft. and the length over buffers is 42 ft. 11 in. The width of the car inside at the top is 9 ft. 3 in., and the width inside at the sills is 8 ft. 5½ in. The sides and ends are ¼-in. steel stiffened at the top edges by 3 in. x 3 in. 6-lb. angles, and angles of the same size are used for corner posts. The sides are further stiffened by angles running the full length of the car above the doors. The doors, of which there are two on a side, half the length of the car, have similar angles, full length, at their lower edges. There are three T iron side posts on each side, to the stems of which are riveted 3-16-in. plates extending across the car and tying the sides to each other. These tie plates are also fastened to the bottom of the car at the ridge line. The doors have downwardly projecting lugs, as shown, and the latching arrangement is a round rod passing through brackets set in the depression of the channel side sill, and running the full length of the car. There are small cams on this rod which rotate from or against the lugs when the rod is turned by throwing its bent end, which acts as a handle bar. The handle bar is locked in place by a gravity pawl, which is pivoted on the end of the car body and is driven free from the handle bar when the doors are to be opened. The light weight of these cars is about 39,000 lbs.

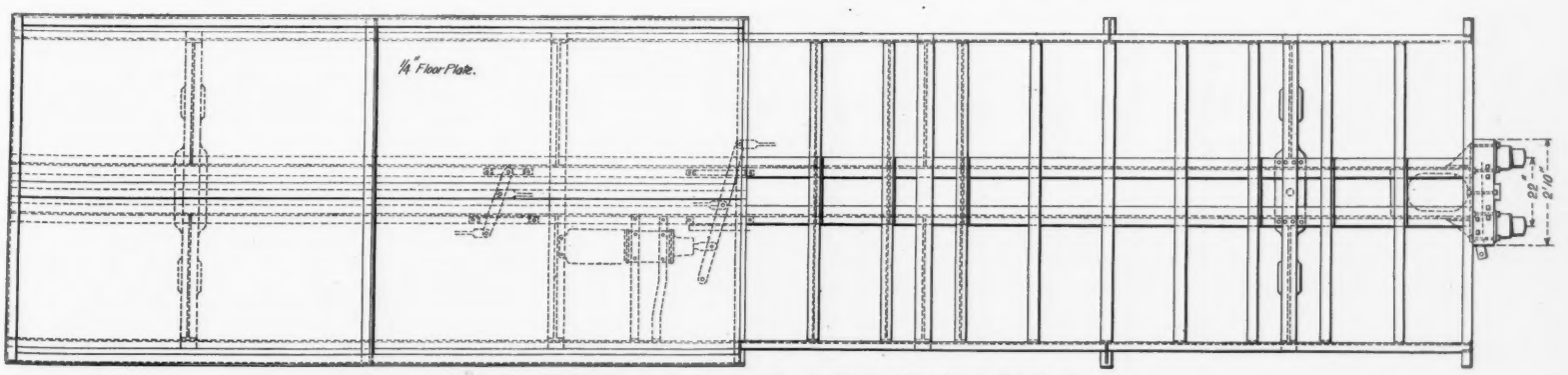
The body bolsters are of original Santa Fe design in cast steel, of the pattern shown in the illustrations, and there are also two cast steel body brackets, which are of the same general outline as the body bolsters in their relation to the car bottom. These brackets are, in fact, a modification of the body bolster castings, and differ only in so far as their duty of supporting the side sills will permit. These bolsters and intermediate body brackets, being each a single unit of cast steel in place of built up members, are among the most interesting features of the work. The bottom plates, which are of ¼-in. steel, are supported by 19 3½ in. x 3½ in. T's, 6.8 lbs. per foot, spaced 2 ft. apart, each of the T's being one piece bent to conform to the bottom of the car and also to the backs of the side sills. The T's are riveted to the side sills and to the bottom plates. They are also secured to the center sills by gusset plates of ¼-in. steel, as illustrated in the transverse sectional view. It is noticeable that the height from top of rail to the bottom of the side sills is only 22 in., and that the center of gravity of the car therefore falls correspondingly low.

A steel draft casting, shown in outline in the longitudinal section of the car, is riveted to the webs of the center sills, the sills being cut away about 3 in. at the bottom to accommodate the lower part of the casting. There are two malleable iron reinforcing bracket castings riveted through both the web of the I-beams and the draft casting. The transverse faces of these right angled brackets, in common with the face of the draft casting, receive the buffing strains. The buffer castings are shown in detail. The spring barrel has a shoulder at the back end, and is slipped through the base casting before the spring is put in, and the complete buffer bolted to the deadwood. This part of the arrangement has worked very well without end sills. American continuous draft rigging and Westinghouse air-brakes are used. The brakes are outside hung, and are suspended from malleable iron brackets, which are riveted to the stems of the T's which form the floor supports. These brackets are illustrated with other car details, and it may be noted that they are so cored that from one pattern brackets suitable for either end of the car are made.



Cross Sections and Details.





80,000-lbs. Capacity Steel Dump Car—Atchison, Topeka & Santa Fe.

An Improved Cast Steel Locomotive Frame.

BY ROBERT M. GALBRAITH.*

In the *Railroad Gazette*, March 25, 1898, page 214, was shown a patented cast steel locomotive frame of my design, chiefly of I-beam section, the dimensions of the frame being given in detail. In that design various modifications of the I-beam section were made to accommodate the working parts of the locomotive and the boiler. The design was essentially the same in general conception as that of the frames which are here illustrated. Patents were also granted to me in 1900 on this later design and its improvements.

In your volume of 1899, on pages 1 and 10, there are expressions of opinion and statements of fact covering practically all that was definitely known of cast steel

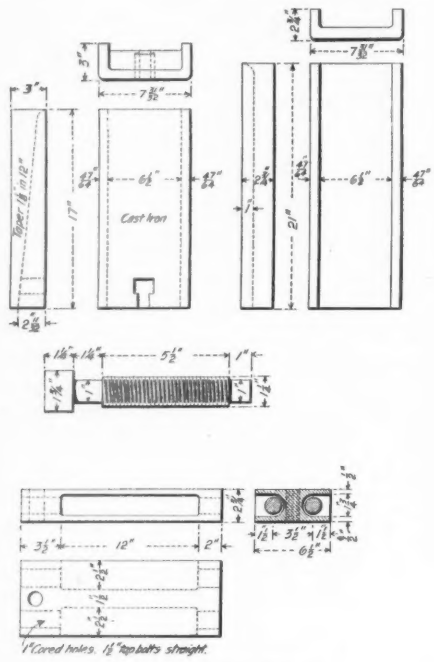
*Formerly General Master Mechanic, St. Louis Southwestern Railway.

frames at that time and offering encouragement to those who were then trying for further development in this direction, myself among the number. On page 424 of the same volume is illustrated a cast steel frame in which cross sections of the upper and lower rails are of general rectangular form, as used on consolidation locomotives of the Atchison, Topeka & Santa Fe. The dimensions of these frames were also given in detail. This design is said to have given better service on that railroad and elsewhere than the average service of wrought iron frames as to endurance and reliability in regard to breaking, and in that respect bears out my earlier experience with cast steel used for this purpose. As a whole, the matter you have previously published seems to invite further report of progress in the use of cast steel frames and the accompanying illustrations are therefore given showing the latest improvements in my design. There are nine locomotives on the St. Louis Southwestern with these frames and two on the Little Rock, Hot Springs & Western, the 11 engines being built from the same specifications, carrying 200 lbs. working steam pressure and having cylinders 20-in. x 26-in. Service records from the nine engines of the St. Louis Southwestern are given herewith, showing the length of time in service, the engine mileage and the total wear of boxes in the pedestal jaws. The driving boxes are cast-steel and all faces are babbitted. My idea in presenting the information in this form is to show what may be accomplished in reducing driving box wear and also the wear of shoes, wedges, and pedestal jaws by having a liberal wearing surface, and also the required stiffness of the entire engine frame.

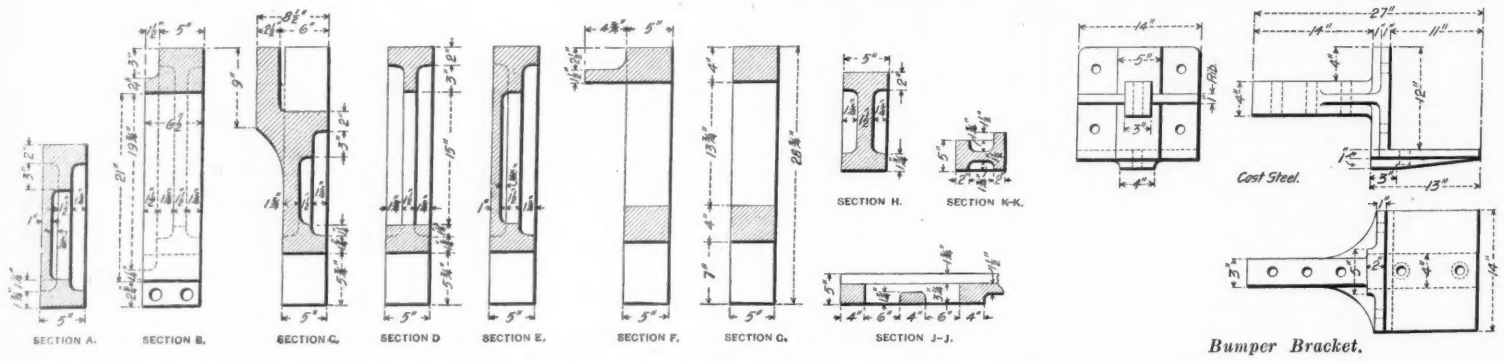
Particular attention is invited to the width of shoes, wedges and pedestal jaws and to the pedestal binder thimbles having two 1½-in. binder bolts through them. The front bumper bracket would also seem to be an interesting feature. The most important improvement is in the uniform thickness of cross section throughout the design, which gives more uniform cooling and shrinkage stresses. There being no large masses of metal, the chance of there being concealed blow-holes is much less. This latter feature has been the cause of much trouble in cast steel frames that were made of solid rectangular sections, and I quote from a man of no small experience with that design of frame, who stated the case as follows: "They are very defective, as they are simply full of blow-holes. I have run a piece of wire 18 inches into a blow-hole in a frame we had down for the purpose of welding, and I have seen some of them, when we took them apart where they were broken, have chunks as large as hen eggs drop out, dross and dirt." Other reports from those who have had the direct supervision of engines built with cast steel frames having large solid cross sectional areas, are in sense to the same effect, although the instance quoted above was probably an extreme one. It should be said in this connection, however, that the question as to whether cast steel frames can be successfully welded, which within comparatively recent time was still regarded as a very serious question, has been disposed of finally in favor of cast steel. Experience shows that there is no material difficulty in welding the frames and that the weld is as reliable, at least, as a weld in wrought iron would be. There is one case of record where flaws were found in the top rail of the front frame of a 10-wheel engine having a cast steel frame and the experiment of cutting out bad portions and welding was deliberately made to see whether the work would endure. The defect was of such extent that it was necessary to cut a V-shaped piece out of both the top and the bottom on the same vertical line, nearly severing the frame rail. Wrought iron pieces of suitable shape were then "jumped" in, a successful weld was made, and the engine having this frame was sent out on the road with others of its class and was never heard from unfavorably by reason of this original defect.

I commenced the use of cast steel frames on locomotives in 1895, placing the first pair on a heavy switching engine that was put in service on an incline from the Mississippi River, the grade being about 2½ per cent. The engine has been there constantly and has required but little repairs since. I then applied the cast steel frames to several 8-wheel passenger engines. Finding that they were cheaper and better in every way, I designed a frame having a better distribution of the metal, reducing the weight 33 per cent. by making it of an I-beam section; cutting out the web in the center, also for the purpose of reducing weight, and giving opportunity for examination of the machinery. In order to increase the bearing of the driving boxes a rib in the shape of an inverted U was cast around the inside of the pedestals, making it possible to use a 12-in. driving box with flanges equal, shoes and wedges being 8 in. wide. The pad for the support of the firebox is cast solid on the frame, which makes a perfect fastening. There are also cast uprights for the support of foundation brakes, and a shelf for the rocker, 10 in. It may also be noted from the illustrations that I provided a front bumper bracket 12 in. x 12 in. This has proven a very valuable device, with the increased weight that is now carried on the front bumper, owing to the application of the M. C. B. Coupler. The frames that were applied to the eleven 20-in. x 26-in. 10-wheel locomotives have been in heavy service. The repairs on shoes and wedges have not been one-half that of engines with the narrow wrought iron pedestals, and there has been no breakage of any kind. One engine that I observed, has had the frame two years with two 1½-in. bolts through the pedestal thimbles, and shows that they have not worked a particle. The thimbles in all eleven of the engines are just as good a fit today as they were when leaving the builder.

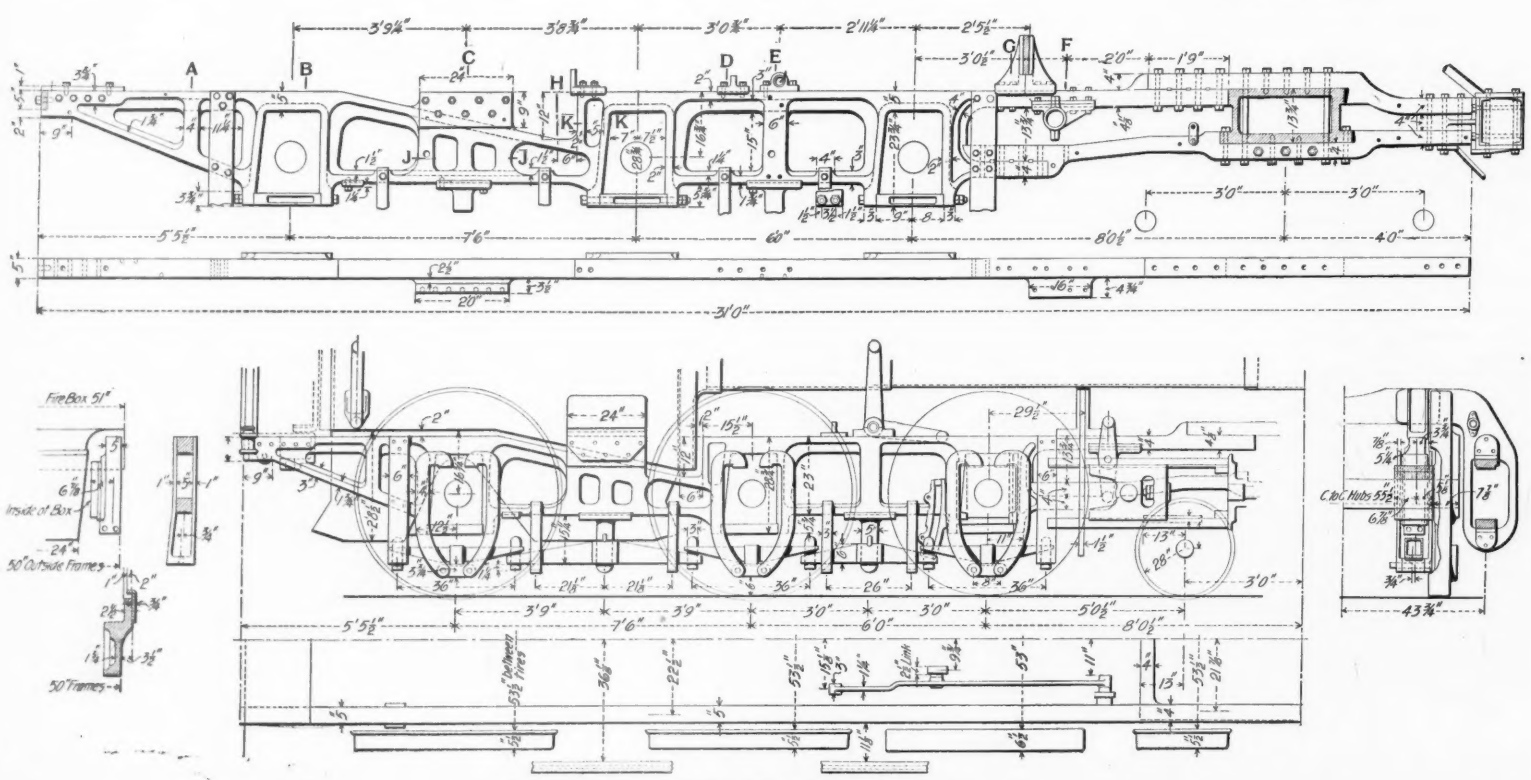
The advantages to be derived from my latest design of frame seem to me to be as follows: The use of cast steel instead of wrought iron removes the possibility of bad welds in regular practice. In case a weld should be thought advisable or become absolutely necessary, the instance previously quoted gives fair assurance that the weld could be made in cast steel with equal or better chances of its holding than if the frames were of wrought iron. In 10 locomotives having wrought iron forged frames, and built at the same time as the 11 engines here mentioned as having cast steel frames, there have been within my knowledge six broken forged frames due to imperfect welding. The



Shoes, Wedge and Binder.



Bumper Bracket.



Galbraith's Improved Cast Steel Locomotive Frame.

steel frame gives a decrease of 40 per cent. in dead weight where the I-beam steel section is compared with the wrought iron frame. Many attachments and braces are integral parts of the frame, thus reducing the cost and trouble of keeping up bolts and nuts. The bearings for shoes and wedges are increased in area 25 per cent. or more, thus making it possible to give driving boxes frame bearings proportionate to the increased power of the modern heavy locomotive. This I regard as a very important consideration in connection with the greater stiffness of frames, previously referred to, and the record of driving box wear which is here given would seem to bear out this belief.

The points of suspension of the driving brake hanger pins strengthen the lower chord of the frame, thus giving a great improvement over what is obtainable where wrought iron is used. The more than usual width at the bottom of the pedestals makes it possible to use the two 1½-in. binder bolts and allow the wedge bolt to be placed centrally where it is more easy of adjustment, being much more accessible than as it is commonly placed. The original cost of this frame is much less than the cost of the wrought iron frame of the same capacity and it has been found that these castings can be made with facility and dispatch. The cost of keeping frames in repair is reduced to a minimum in this design and it is possible to produce frames which will outlast the life of the ordinary locomotive. The record of the pedestal wear of driving boxes on nine engines of the St. Louis Southwestern is given. The blueprints from which the illustrations are made, and also this record of driving box wear were obtained from Mr. T. A. Adams, General Master Mechanic of the St. Louis Southwestern.

Pedestal Wear of Driving-Boxes in Galbraith Steel Frame.

Engine o.	Entered Service.	Mileage.	Original Dimension.	Present Dimension.	Total Wear.
200....	Sept., 1898	93,231	13 in.	12¾ in.	¼ in.
201....	Sept., 1898	92,156	13 in.	12¾ in.	¼ in.
202....	Oct., 1898	80,469	13 in.	12¾ in.	¼ in.
203....	Sept., 1898	90,922	13 in.	12 11-16 in.	5-16 in.
204....	Sept., 1898	80,998	13 in.	12 11-16 in.	5-16 in.
205....	Sept., 1898	91,260	13 in.	12¾ in.	¼ in.
206....	Dec., 1899	53,172	13 in.	12⅞ in.	⅛ in.
207....	Dec., 1899	52,078	13 in.	12⅞ in.	⅛ in.
208....	Dec., 1899	52,901	13 in.	12 13-16 in.	3-16 in.

Extension Piston Rods and Wear of Locomotive Cylinders.

BY J. L. DOHERTY.

Readers of the *Railroad Gazette* will doubtless recall the discussion on the advisability of using extension piston rods, and the results obtained by their use, which forms a part of the Proceedings of the Master Mechanics' Association for 1899. From that discussion it was apparent that there were those who regarded the extension of the rod as a necessity and others who considered it entirely useless. Opinion seemed to be almost evenly divided on the subject, with perhaps the weight of evidence somewhat in favor of using the extension, and it may not be amiss to quote from the opening paragraph of Mr. R. H. Soule's contribution to the subject at the time mentioned. Mr. Soule said in part: "I find that there is very little fixed opinion on the subject among railroad men and no unanimity of opinion among the locomotive builders. I heard of one road, the New York Central, which has made it a rule in recent years that all cylinders 19 inches or upward in diameter shall have their piston rods carried through the front ends. I heard from a locomotive builder that in their own family they did not consider that it was necessary to apply the piston rod extension unless the cylinder was 28 inches in diameter and upward. So you see at once there are wide limits of opinion bearing on this question. . . . But there is this consensus of opinion among locomotive builders—they all feel that the piston rod extension in some approved form, when the practice has reached a final stage where it commends itself to the railroads, will be a necessary feature of all future large, powerful locomotives. But quite a number of details remain to be worked out, and I do not think it can be said yet that any device that has been put out is an absolute success."

The discussion that followed Mr. Soule's opening, it may be recalled, brought out direct and positive statements tending to show that the use of the extension piston rod had directly reduced cylinder wear; and also statements just as positive to the contrary. From one of the latter the following words are quoted: "I have had some experience with the extended piston rod and I fail to find any value in it whatever."

Within the observation of the writer there has been ample opportunity to note the wear of cylinders on locomotives having extension piston rods and working where a large measure of their movement was made while drifting. As the interest in this question has thus far turned largely upon the action in drifting it has seemed that some direct statements, with the illustrations given herewith, might have some value in this connection.

About three years ago some 21 x 28-in. consolidation engines carrying 185 lbs. steam pressure, and also some 20 x 28-in. engines carrying the same pressure were fitted with extension piston rods. The 20 x 28-in. engines had 3¾-in. piston rods and the 21 x 28-in. engines had 4-in. piston rods, all extension rods being three inches in diameter. The piston heads were cast steel with cast iron snap rings 1 in. wide x ⅝ in. thick, and the extension rod played, through a brass bushing 9 in. long and bored 3 1-32 in. diameter, into a cast iron shield or pocket which completely enclosed the rod extension. The brass bushing was made a neat fit in the front cylinder head and lubrication was expected from the oil which was held in suspension in the steam in the cylinders. It was soon found that the bushing would not support the rod, and that the wear at that point was very rapid, two or three trips over a division about 100 miles long wearing the bushing enough to let the piston head down upon the bottom of the cylinder. It was at first thought that there was insufficient lubrication in the brass bushing and also that the solid piston heads were playing an undesirable part in the cutting of cylinders, which was very rapid. The solid piston heads were taken off and the pistons were fitted with bull-rings, followers, and snap rings 1 in. wide x ⅝ in. thick, thus in the matter of spring rings being the same as those mentioned above. By frequently lining up the bull-rings the life of the brass bushing on the extension was prolonged, but the cutting of cylinders was almost as great as before the change was made, for the piston was now riding on the bull-ring, and, of course, carrying the extra weight of the extension rod. However, the extra weight of the extension could not account for the rapid wear in the bottom of the cylinders.

Eventually, the shield or pocket in which the extension rod worked was taken off, and the front ends of the cylinders were fitted with a brass bushing and a short gland having metallic packing, as shown in Fig. 4 in connection with another feature, which was not used, but mention of which will be made later. This gave ready access to the extension rod in observing its condition, and also in the matter of lubrication, as an oil cup was used on the top of the gland, and a great improvement was noticeable in the cylinders, although they were still cut to an extent that was very unsatisfactory. Without entering too deeply into details of expedients resorted to in fitting packing rings and followers it may be said that the gland described was applied to engines ranging from 19½ x 28 in. to 21 x 30 in. and carrying as high as 200 lbs. steam pressure. It was possible to turn the bushing that was used with the metallic packing, and thus take up the wear on the bottom by turning the worn side of the ring to the top of the extension rod. Among later developments was rapid wear of cylinders at the top, and it is the opinion of the writer that where cylinders are thus cut in a manner to show directly opposed causes, cutting is not the result of the kind of packing ring or piston head, the steam pressure used (although high steam pressure does bear upon this subject), nor the nature of the work done as to drifting or working under steam; but that it is largely caused by bent pistons, guides out of line and crossheads improperly put up.

It is at once apparent that supporting the piston head at both sides, as where the extension rod is used, makes it even more than usually necessary that the guides and crosshead should be in parallel line with the center line of the cylinder; otherwise the distortion of the piston rod becomes as shown in Figs. 1, 2 and 3, where the bends are purposely exaggerated to show what has been found by the writer when testing piston rods in a lathe. Cylinders within the range of stroke and diameters previously given have been known to require boring out 7-16 of an inch diameter after being in service from six to eight months; cylinders have been bored twice in 90 days, and have been bushed on engines that were in service less than one year. This was in exceedingly hard service, probably half of the total mileage being made while drifting, but it would seem that no service could quite justify so great deterioration, and these conditions would tend to establish the belief that, while the extension piston rod may or may not be a necessity, when it is allowed to go wrong it goes farther wrong than it is usual for the ordinary rod to do.

It has been observed that a piston having the extension rod may cut a cylinder in five different ways. First, on top toward the head end; second, on top toward the crank end; third, on the bottom at the head end; fourth, on the bottom at the crank end, and fifth, at both top and bottom practically throughout the stroke, thus changing the entire cylinder bore from a circle to an oblong. When piston rods are bent it will usually be found that there are two or more bends, and a defect in guide alignment, or trouble with the crosshead will be found. In the case of a cylinder cut on the bottom at the head end, if the cutting is caused by a bent rod, the bends will be as shown in Fig. 1, and the cylinder will be worn as there shown, the cutting being done on the forward stroke. If the cutting is caused by guides out of line they will be found high in front or high throughout their length. The crosshead may be so out of line with its rod fit as to give the same effect, and cutting in that case will be on the backward stroke.

When the cylinder is cut on top at the crank end the bends are in the same direction, but the extent of them may be different. As shown in Fig. 1, they are such that the piston is thrown to the top of the cylinder, while in Fig. 2 it is thrown to the bottom of the cylinder and cutting takes place on the backward stroke. In the conditions referred to as fifth, the bends would be opposite and of equal extent, thus keeping the piston on an average center line, but cutting of the cylinder would occur on both strokes, and in this connection reference may be made to Fig. 3. It is the belief of the writer that the proof of these opinions is in the hands of all who are using extension piston rods, and that it is desirable to draw attention to the need of a close alignment of glands and guides where it is thought necessary to use the extension piston rod.

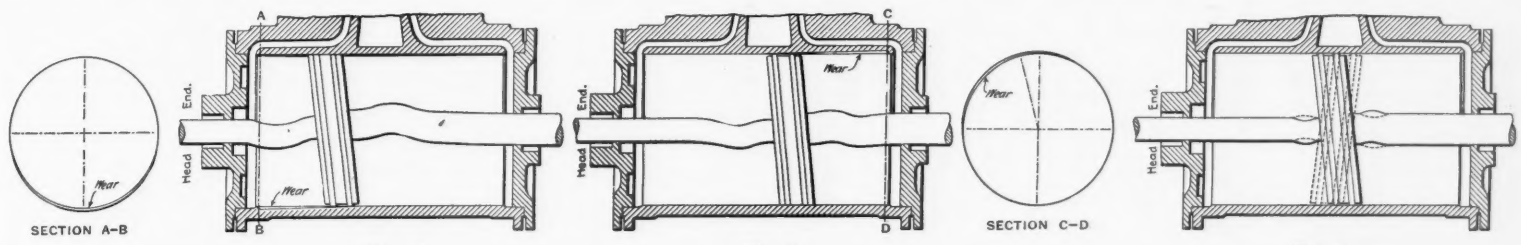


Fig. 1. *Fig. 2.* *Fig. 3.*

Extension Piston Rods and Wear of Locomotive Cylinders.

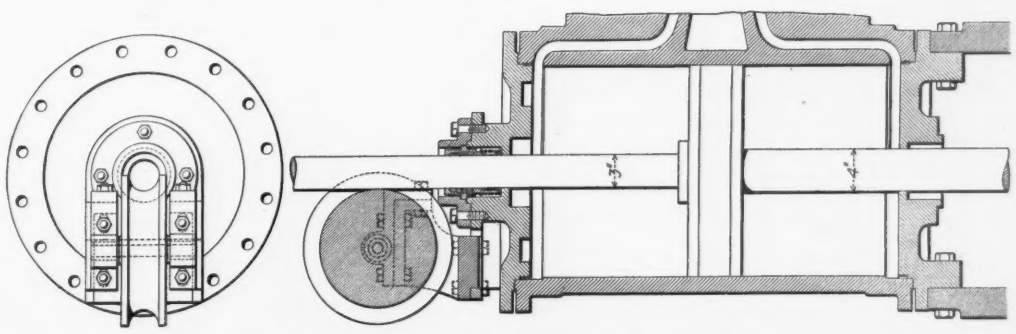


Fig. 4.—Proposed Method of Extension-Rod Support.

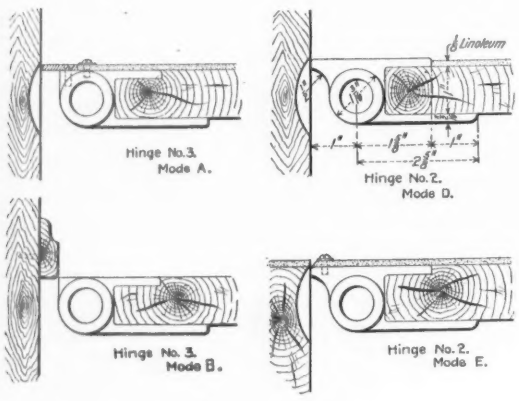
It has been my idea that the extension rod could well be supported upon a simple sheave mounted on the front cylinder head, as shown in the accompanying illustration, Fig. 4. Further than this, it was my belief that a system of rollers might well be introduced into the crosshead and made to take the crosshead friction upon the guides. Following this idea the design shown in Fig. 4 was made, and also a crosshead design which is not there included. Application for patents upon these devices brought out the fact that as long ago as 1871 Mr. David R. Fraser patented practically all the essential features of the design, although his idea differed in minor details. The idea in itself is therefore not patentable, and the patents of 1871 have now elapsed by time limitation. My conception of this adjustable sheave requires little explanation to make clear the accompanying illustration. It would simply be a sheave of the relative proportion there shown, the face of the sheave being concaved to conform to the 3-in. extension rod

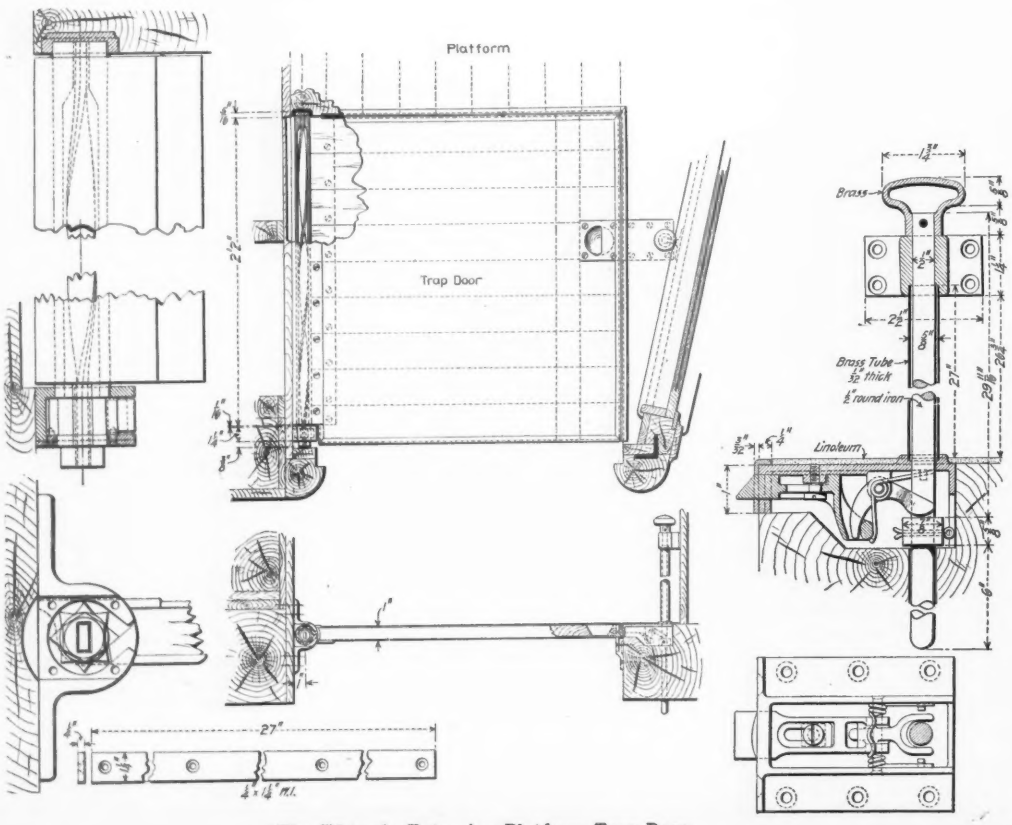
and the bearing in which the sheave is mounted being adjustable vertically to accommodate itself to conditions of wear. The wearing of the rod in its play upon the sheave, doubtless with a tendency to wear the rod out of round, is a vital feature when the packing gland through which the extension rod works is considered. Having given that consideration to the arrangement, it is my belief that much good would result and a great economy in cylinder wear be effected by the use of some form of this simple device on the extension rod. From my observation it would seem that supporting a heavy piston at its forward end is not only theoretically correct, but that with proper care it can be done in practice; that the lubrication of the brass or other gland through which the rod passes offers no insurmountable obstacle to the use of the extension; and that the extension piston rod is a material help in maintaining motive power equipment when it is properly used and cared for, even while it is capable of working a measure of destruction that makes it a very expensive member when neglected.

The Edwards Extension Platform Trap-Door.

In the *Railroad Gazette*, Sept. 7, 1900, we gave a description and outline illustrations of the Edwards extension platform trap-door as made by the O. M. Edwards Co., under the Seymour & Kahler patents, issued in 1899. The accompanying illustrations show the door and fixtures quite fully. It is very simple in design and has won a wide recognition from regular application on many cars in first class trains of several of the large railroads. The cost of applying is very small. By referring to the illustrations it may be seen that an old car already in service can be fitted as readily as a new one in course of building, the application of the fixtures calling for no change or cutting upon the car.

Several modes of applying the hinges to the door, both with and without linoleum or rubber covering, are shown. The torsional spring extending throughout the length of the hinge is also shown. This spring consists of a flat bar, one end of which is held in the hinge, the other end being held in the ratchet wheel located in the bracket or journal which is attached to the body of the car. By means of this ratchet wheel the torsion of the spring can be regulated as desired, either to balance the door or to have it open automatically to a perpendicular position upon releasing the catch by means of the operating handle. The latching device is shown in detail and, like the rest of the design, is so simple and effective as to require no lengthy description with the illustrations here given. The door as a whole has steadily gained friends and will doubtless continue to do so as its manifest advantages become better known.





The Edwards Extension Platform Trap-Door.

The Works and Some Products of the Pressed Steel Car Company.

[WITH AN INSET.]

In the four great plants of the Pressed Steel Car Company illustrated in the inset, over 10,000 men are employed and for months past these mills have been running night and day. Two of the plants, those at Pittsburgh and Joliet, are utilized for the manufacture of truck frames, bolsters, brake-beams, side stakes, center plates, and other pressed steel specialties for wooden and steel freight car construction, while the much larger plants at McKee's Rocks and Allegheny are given up to the building of freight cars. During the four years since the first steel car was built nearly 45,000 cars have been built in these two plants and during the month of May alone, 2,705 finished cars were turned out and shipped. At the present rate of output, the company will build nearly as many cars this year as have been constructed since its inception.

The plant at McKee's Rocks, Pa., the largest one of the company's works, was completed in July, 1899, at a cost of over $1,500,000. It consists of 96 acres, of which 13 acres are covered with new steel buildings of the most approved design. In 1900 a plant for the manufacture of wooden cars with steel underframe was added to these works. The capacity of the addition is 40 cars per day and of the entire plant 100 cars per day.

The plant at Allegheny, Pa., consists of 27 acres, of which 10 acres are covered with steel and brick buildings. The capacity of this plant is 50 cars per day.

The plant at Joliet, Ill., consists of 2½ acres covered with well constructed improved buildings of stone and steel.

The plant at Pittsburgh, Pa., has 1½ acres covered with steel buildings.

The cuts illustrate some of the cars and car parts built by the Pressed Steel Car Company, and also the behavior of steel cars in wrecks. The two wreck cuts, which are from photographs, show steel cars practically uninjured by shocks which would totally destroy wooden cars.

Canvas-Covered Coach Roofs.

Covering the roofs of passenger coaches with canvas, and the best method of doing it, is a much-discussed subject, and one which is still open to debate in the minds of many car builders. If the canvas is stretched over the unpainted roof, and is then heavily painted on its exterior the weakness of the combination lies in the fact that there is no union, and in fact no positive contact between the under side of the canvas and the roof. With the deterioration of the fabric, its looseness and tendency to undulate when the train is moving hasten its destruction. If the canvas is painted on both sides and then similarly applied to the car roof the life of the canvas may be longer, but the probability is that it will be rendered so brittle that it will break, loosen, and make an annoying sound by beating upon the roof when wind causes it to flap.

An excellent method that has been in use for a number of years by several prominent car builders is described as follows: The roof boards are thoroughly seasoned, and then dressed at all points so as to make a perfectly smooth and even surface. They are then coated with white lead, thinned with raw oil to the consistency of a heavy paste, and No. 3 duck canvas, the under side of which is coated with white lead and oil made thin enough to thoroughly saturate the canvas, is laid on the roof. In applying the canvas it is securely tacked at one end of the roof, and to the other end of the canvas a windlass is attached by which it is stretched as tightly as desired. It is then secured to the roof on all edges by two rows of heavy tinned tacks. A roller is then passed over the canvas until the lead is forced through the texture, and in this way the canvas is cemented to the roof boards. When the lead is dry, roofing paint is applied in the usual manner.

To thus roof a 60-ft. coach requires about 200 lbs. of prepared white lead, and we have a record of cars that have been running for 20 years with canvas applied in this manner, the repairs upon them during that period being of the slightest and most ordinary character, as, for example, an occasional patch, from whatever cause. It is found that when it becomes necessary to remove canvas put on in the manner described it has practically become a part of the car roof, and it is necessary to cut it off with an edged tool to separate it from the wood.

The Friction of Brake Shoes.

BY R. A. PARKE.

A Review of Experiments to Date.

The ideal simplicity of the earliest conclusions concerning the laws of friction, as enunciated by General Morin, brought the whole subject almost within the scope of mental arithmetic. The law, as originally stated, was that the friction between two given surfaces is merely proportional to the force with which they are pressed together. There were no modifying influences to be considered, except that friction was reduced by lubrication and increased by "adhesion," in cases where there was little or no motion, so that the apparently increased friction of rest was due only to added effect of adhesion. It was necessary only to determine a constant coefficient of friction for the surfaces of any two given materials and to multiply that coefficient by the pressure with which the surfaces were forced together and the product became the frictional resistance to motion. To be sure, there were different values of the coefficient of friction for different materials, but this coefficient once determined for any two surfaces of given materials, the law of unlubricated dynamic friction between those two substances was fully established.

It would be expected that so simple and attractive a disposition of any mechanical subject would insure it ready and undisturbed recognition, and indeed such was the case for many years. There were conditions, however, under which patient persuasion failed to secure obedience to this desirable and far from oppressive law, which raised doubts and misgivings in mechanical minds that insisted upon further inquiry. The Westinghouse-Galton brake-shoe friction experiments of 1878 were instigated through such doubts and were projected for the purpose of making such an investigation as should either confirm or indicate the defects of the laws of friction as then generally accepted. Through these experiments, the beautiful simplicity of the subject, as theretofore understood, was suddenly submerged in a sea of intricacy which has not yet been reduced to anything bordering upon systematic order or even sufficiently analyzed to fully and clearly expose the character of its component factors. Lubricated friction has since then been subjected to considerable investigation and much information of practical usefulness has been obtained. Still, such investigations have generally been of a somewhat fragmentary nature, each conducted for some special conditions of comparatively narrow range, and the results have been generally so arbitrarily formulated that there is no continuity of expression capable of covering a broad range of conditions and no comprehensive view of even that branch of the subject has yet been obtained.

The investigation of unlubricated friction, so auspiciously and admirably launched in the Westinghouse-Galton experiments, has resulted in practically no advancement in our knowledge of the subject in all the years that have since elapsed. Notwithstanding the immense stride which those experiments accomplished toward unraveling the subject, and the comparatively clear view they exposed regarding the proper character of additional investigation, nothing has since been accomplished except to confirm the conclusion, hinted in Capt. Galton's report, to the effect that the field covered by those experiments was not sufficiently broad to permit a clear enunciation of the law controlling the subject. The reasons for the apparent apathy concerning so important a subject are not very difficult to find. The cost of the necessary equipment and the character of the

facilities required, have placed satisfactory investigation beyond the reach of most of those who would undertake it for the sake of its scientific interest. The most important practical utility of the effect of unlubricated friction is realized in railroad-vehicle brakes, and here the facilties for investigation appear to be abundant; but the Westinghouse-Galton experiments so clearly foreshadowed the expenditure of time and patience that must accompany the attainment of comprehensive and conclusive results, that each railroad organization seems to have shrank from the undertaking in the hope that some other would feel better justified in attacking the problem.

The first actual movement giving promise of elucidation of the subject was the construction of the Master Car Builders' brake-shoe testing machine. It was hoped that this apparatus might furnish both the facilities and inspiration for such a methodical and complete system of experiments that the complicated action of brake shoes during the stopping of a train might become not only analyzed and understood but also so reduced to a comprehensive, even if complex, statement of law that, under any given conditions, an accurate forecast of that action and of the resulting length of stop could be readily encompassed. Thus far, the results of experimental use of the apparatus have proved disappointing to those who had hoped for such an investigation. The tests so far undertaken appear to have been wholly directed toward the determination of standard specifications for acceptable brake shoes. It seems not unnatural that this purpose should have been considered of first importance; but it may also be true that this purpose would itself be finally accomplished in a more simple and satisfactory maner if anticipated by experiments which would lead to a better knowledge of the laws of friction themselves.

The most recently published statements concerning the methods, results and conclusions in connection with experiments with this apparatus are those contained in a paper presented at a meeting of the Western Railway Club in September last. The paper is in the nature of a report upon a series of tests apparently designed to determine the outlines of a suitable system of standard tests for brake shoes, and contains recommendations in that direction. But, in addition, it also sets forth formulated conclusions, of a seemingly broad and general character, concerning the effects of variations of pressure, speed and temperature upon the coefficient of friction, which conclusions have apparently an important bearing upon the subject. It cannot be doubted that the source of the paper clothes its conclusions with a certain measure of authority, particularly as a portion of them are announced with expressed confidence. Both for this reason and because of the harassing character of the obstacles generally presented to systematic and conclusive investigation of the subject, it is to be feared that the statements and conclusions expressed in the paper may be accepted as of an authoritative and final nature, to the discouragement of independent effort in such a difficult field of operation. This fear, coupled with the conviction that clearer general comprehension of the present state of our actual knowledge of the subject is a necessity to its continued progress, constitutes the sole inspiration and motive for the following attempt to disclose certain pitfalls in the lines of present investigation and to give a clearer view of what past investigation should teach us. As the Railway Club paper deals with most of the more immediately important features of the subject, and as the accuracy of several conclusions expressed in it can hardly be accepted, it is convenient to consider the real status of the subject through serial treatment of the more important statements and conclusions of that paper.

It may be stated in the outset that one of the chief sources of difficulty in recent methods of investigation, which also appears to be responsible for some misleading statements in the paper, is a confusion of terms, arising from the employment of the computed mean value of the continually varying coefficient of friction during a stop, made from any particular initial speed, as a quantity of reference and comparison. This quantity, which may be designated as the "mean coefficient of friction," is an artificial quantity computed from an automatically recorded diagram, is affected by a variety of fluctuating influences and bears the same relation to the wide range of fluctuating values of the coefficient of friction during a stop that the mean effective pressure in an engine cylinder bears to the varying steam pressures during a complete stroke of the piston. It is possible that this mean coefficient of friction may be found a desirable standard of reference in comparing the behavior of different brake shoes in experiments upon a testing machine, although in what respect it possesses special advantages for that purpose is not clear. At any rate, it is to be regretted that its employment for that purpose seems to have led to such an extension of its use as to make it a basis for broad conclusions concerning the laws of friction. Its wholly uncertain character, because influenced and modified by several shifting causes of variation of the actual coefficient of friction during a stop, not only renders it an unsuitable medium of analysis of the laws of friction but its employment for that purpose is apt to lead to complication and confusion. It is not difficult to imagine how little progress would have been made indetermining the properties of steam under pressure through a comparison of the mean effective pressures computed from indicator cards taken from an engine cylinder under various operating conditions. Such a comparison might present features of interest, but it could form no sound basis for discovering the causes of variation of the steam pressure or for predicting the mean effective pressures in the cylinder of a different class of engine operating under different conditions. At any rate, mean values of the coefficient of friction, computed from the diagrams representing the fluctuation of the coefficient of friction from a variety of combined causes, should not be treated as representing the coefficient of friction itself or as bearing any commensurable relation to it.

Although the Railway Club paper states only three formal conclusions, it contains two other important statements, and, as the five comprehend the chief peculiarities of the subject as thus far investigated, they will be considered serially. They are as follows:

"The coefficient of friction decreases as the pressure increases, within the limits of the tests."

"The coefficient decreases with increase of speed, except from ten to twenty miles per hour, between which points it increases slightly."

"The coefficient is generally nearly constant from shortly after the start until just before the stop, when it rises from 1½ times to twice the average value."

In tests where a constant speed of the wheel is continuously maintained, "the curves show that the coefficient of friction is practically a constant."

"Within the limits of the tests, the temperature of the rubbing surfaces does not affect the coefficient of friction."

The Effect of Pressure.

The first of these conclusions, that the coefficient of friction decreases as the pressure increases, agrees with the results of some previously published tests. The conclusion is equivalent to the statement that the coefficient of friction is an inverse function of the pressure, which is an important addition to the information furnished in the reports of the Westinghouse-Galton tests. It is quite in accordance with what should be expected from the nature of the most plausible explanation of the actual phenomenon of frictional resistance; that is, all surfaces are characterized, in greater or less degree, by elevations and depressions, due to porosity, unevenness of texture and mechanical treatment, which become interlocked when the surfaces are pressed together. Motion between surfaces so pressed together is necessarily accompanied by more or less abrasion, cutting and tearing of the interlocked articles and consequent wear of the surfaces. Naturally, the surface irregularities become more completely interlocked as the surfaces are more forcibly pressed together and the resistance to motion therefore increases with increased pressure. But the more prominent or coarser superficial irregularities, which present the relatively greatest effective resistance to motion, become engaged through even light pressures; and, while increasing pressures progressively engage an increasing number of irregularities, they are of rapidly diminished size and resistance, so that the friction does not increase in proportion to the increase of pressure.

That is, the coefficient of friction becomes smaller as the pressure increases. It seems quite certain, however, that the coefficient of friction cannot continue indefinitely to decline at a uniform rate with increase of pressure, for, otherwise, it would only be necessary to sufficiently increase the pressure in order to reduce the coefficient to zero and thereby eliminate friction altogether—an inconceivable condition. It may reasonably be expected that, as the pressure continues to be increased, a condition is approached in which nearly all the surface irregularities become interlocked and thereafter the coefficient of friction would remain practically constant. It is not unlikely that such a condition would be reached only with great pressure, perhaps so great as to result in crushing the material of the surfaces. The actual variation of the coefficient of friction through widely differing pressures between unlubricated surfaces of a given area of contact, has not yet been determined; but it may be confidently expected that, for the same speed and temperature, the coefficient of friction will be found to be a maximum for very light pressures, to decline rapidly as the pressure begins to increase, and to continue to decline, but with constantly decreasing rapidity, as the increase of pressure progresses, thus approaching a minimum limit, which may, however, not be actually realized within the limit of crushing pressures.

A disappointing feature of the conclusion formulated in the Railway Club paper, respecting the effect of variation of pressure, is that it appears to be based upon comparison of the values of the mean coefficient of friction computed from stop tests, which values are complex functions of variation of the speed and of other influences as well as of the pressure. Data of the kind published is not suitable for a satisfactory analysis and supplies no basis for accurate conclusions of such a nature. The general character of the conclusion drawn supports, so far as it goes, the theory above offered with reference to the ultimate relations between the coefficient of friction and the pressure; but this branch of the subject of brake-shoe friction must yet be submitted to a much more systematic and comprehensive investigation, the proper character of which will be considered hereafter.

The Effect of Speed.

The second statement, that "the coefficient of friction of brake shoes decreases with increase of speed, except from about ten to twenty miles per hour, between which speeds it increases slightly," is very unfortunate. Examination of the data published with the paper discloses the fact that the statement is founded upon a comparison of the values of the mean coefficient of friction during stops made from various initial speeds. The mean value of the continually varying coefficient of friction seems to be treated as if it actually represents the coefficient of friction; and the intial speed, which exists for a single instant only during the stop and then declines (in accordance with a law involving the variation of the coefficient of friction itself) through all the inferior speeds down to zero, is made the basis of speed reference. If the statement were couched in terms expressive of the actual conditions, it would be less open to objection, though not entirely free from criticism, inasmuch as the practical utility of the information may be seriously questioned, for reasons hereafter given; but, as it stands, the statement conveys an impression which is incorrect and misleading.

If any single essential principle involved in the laws of friction may be regarded as definitely established, it is the inverse relation between the coefficient of friction and speed. Other influences remaining constant, increase of speed, from a state of rest up to the highest velocities entering into past experiments, is accompanied by a continuous and regular decrease of the coefficient of friction. There is no such break in the continuity of this law as would seem to be indicated by the statement that, between the speeds of 10 and 20 miles an hour, the coefficient of friction increases. The quantity which is found to increase between those speeds is not the coefficient of friction, and, moreover, the relation between the coefficient of friction and speed cannot be reliably determined from stop experiments. Experiments in unlubricated and in various degrees of lubricated friction all point to this characteristic law, though the difficulty of preserving uniformity of other conditions at different speeds, especially in lubricated friction where the physical condition of the lubricant cannot be maintained constant, may sometimes result in seeming irregularities. The law was first discovered in the Westinghouse-Galton experiments and its character was clearly disclosed in the tabulated results of Captain Galton's published reports. If confirmation were necessary, it is abundantly supplied in the results of later experiments. It is illustrated in the diagrams published with the Railway Club paper. Nearly all the stop diagrams clearly show that, as the lower speeds are reached near the end of the stop, the coefficient of friction continuously rises. This is particularly true of the stops made from the higher initial speeds. Those made from comparatively low initial speeds may seem to indicate a decline of the coefficient friction as the speed approaches 10 miles per hour; but the coefficient always has a tendency to decline during the early part of a stop, from whatever initial speed, through an entirely separate cause, and these stops from low initial speeds supply no ground to justify the general statement that the coefficient of friction increases as the speed increases through the range of from 10 to 20 miles per hour.

The actual relation between the coefficient of unlubricated friction and speed was fairly well defined in the Westinghouse-Galton experiments. The friction of rest, formerly regarded as a combination of friction with adhesion, seems to have been quite clearly shown to be merely a particular and extreme case of the friction of motion although, in lubricated friction, the viscosity of the unguent appears to exercise an additional influence upon the friction of rest. From the friction of rest, the coefficient of friction regularly and constantly decreases for increased velocities, the decrease being very rapid at first, but continually less rapid as the increase of the velocity progresses, up to the highest velocities of experiment. This relation is rationally explained by the interlocking theory. When motion between surfaces is rapid, there is less time for the interlocking of the particles to occur, and consequently, under the same pressure, the interlocking is less complete than at lower speeds. When at rest, the interlocking is as complete as can occur under the pressure employed; but as the speed is increased the interlocking becomes less and less effective, so that, at very high velocities, interference occurs only between the summits of the more prominent projections upon the surfaces. It is manifest, however, that, although the coefficient of friction must be expected to continue to decrease as the speed is indefinitely increased, there will always be some frictional resistance at any finite speed, however great, and therefore the coefficient of friction cannot actually become zero for any finite speed. That is, stated in general terms, the coefficient of unlubricated friction has a maximum value when the speed is zero, from which its value declines, rapidly at first and thereafter continually more slowly, for increased speed, and approaches the value of zero as the speed approaches infinity. These are the conditions upon which a mathematical statement of the law must be based. They definitely preclude such expressed conclusions as that the coefficient of friction is found to vary according to the square root of the speed. While it is undoubtedly true that, for a comparatively narrow range of speeds, the results of experiment could be formulated with sufficient accuracy upon that basis, yet such formulated statements are fragmentary and the assumed relationship cannot correctly represent a wide range of the conditions, as its employment inevitably leads to error when indefinitely extended. The curve of relationship so formulated is necessarily a parabola, the axis of which is parallel to the axis of speeds. It is certain therefore that, for some finite speed, the curve will cut the speed axis and give a zero value for the coefficient of friction, while, for all greater speeds, the coefficient of friction acquires a negative value—an obvious absurdity. Expression of the law is clearly restricted to a mathematical curve to which the axis of speed becomes tangent

at infinity. The curve most naturally suggested as complying with the requirements is the equilateral hyperbola. If f' represent the coefficient of friction and V the speed, the curve of relationship is represented by the equation $f' = \frac{a}{1 + b\,V}$, in which a and b are constants suitable for the materials and conditions, to be determined by experiment. It will be observed that the maximum value of f' (equal to a) occurs when V is zero, and that it declines, at first rapidly and then continually more slowly, as V is increased from zero upward, becoming zero only when V is infinity. Unfortunately, no experiments have as yet been so conducted that the values of the constants a and b may be satisfactorily determined for brake shoes rubbing upon car wheels. The only data available is that furnished in the Galton reports, and that is unsatisfactory because of the omission to record the brake-shoe pressures in the experiments furnishing the data. A vast number of separate tests were made at different constant speeds between the limits of bare movement and of 60 miles per hour. The observed coefficient of friction for each of the different speeds varied considerably, as indicated by the maximum and minimum values published, and it is impossible to judge of the extent to which such variation is due to variation of pressure, in the absence of record. The experiments at each different speed appear to have covered a variety of pressures, and it is not unlikely that the mean value of the coefficient of friction for each speed represents a mean pressure approximately applying to all the speeds. Assuming that such is the fact, the mean values of the coefficient of friction for various speeds have been formulated and furnish for a the value .326 and for b the value .03532. The following table shows in parallel columns the mean values of the observed coefficients of friction for different speeds, and also those calculated from the formula $f' = \frac{.326}{1 + .03532V}$

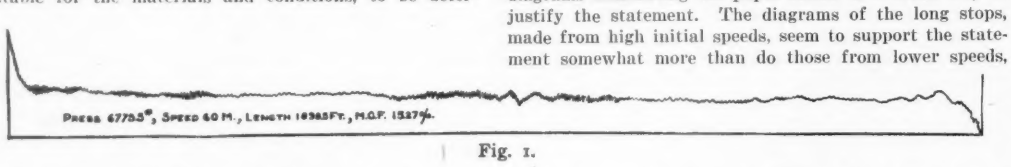


Fig. 1.

Speed, V, Mi. per Hr.	Coefficient of Friction, f', Calculated.	Observed.
0	.326	.330
5	.277	.273
10	.241	.242
15	.213	.223
20	.191	.192
25	.173	.166
30	.158	.164
35	.146	.142
40	.135	.140
45	.126	.127
50	.118	.116
55	.111	.111
60	.105	...
65	.099	...
70	.094	...
80	.085	...
90	.078	...
100	.072	...

It is to be noted that the constant a of the formula is to be regarded as constant only for a given brake-shoe pressure; it must be regarded, and perhaps also the constant b, as a function of the pressure, with which it varies by some law as yet undetermined and determinable only with the aid of experimental data of a more suitable character than any yet published. Inasmuch as the particular pressure, for which the constants a and b have the values employed in computing the above table, is unknown, the formula as it stands has no practical utility. But it undoubtedly represents, with approximate accuracy, the fluctuations of the coefficient of friction under a specific set of conditions which remain practically constant while only the speed varies, and it may thus be usefully employed for the purpose of illustration, as presently shown. It may be stated, therefore, that, so far as our present knowledge extends (and other considerations, presently discussed, seem to satisfactorily confirm the correctness of the conclusion), all other conditions remaining uniform, the coefficient of friction continuously and regularly declines as the speed increases. Conversely, if, during a stop, it were possible to preserve the intial conditions unaltered, the initial coefficient of friction would continuously increase as the speed decreases.

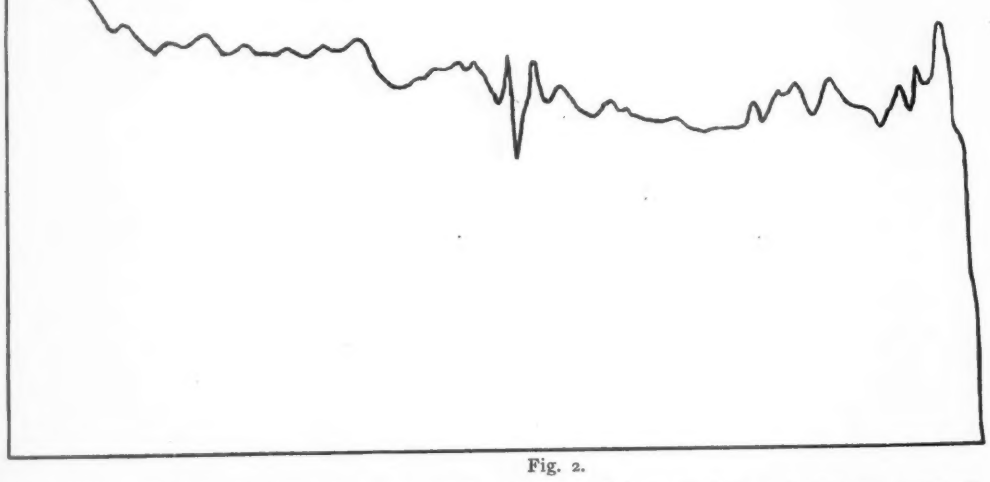


Fig. 2.

Behavior During a Stop.

The third statement of the Club paper, that "the coefficient is generally nearly constant from shortly after the start until just before the stop," is evidently intended as a general observation of an approximate rather than an exact character. A superficial examination of the diagrams illustrating the paper seems in a crude way to justify the statement. The diagrams of the long stops, made from high initial speeds, seem to support the statement somewhat more than do those from lower speeds, while the shortest stops, made from quite low initial speeds, would scarcely suggest such a view. A careful analysis, however, of even the longest diagrams, brings to light a most interesting and instructive characteristic fluctuation of the coefficient of friction during a stop, which has a very important bearing upon this and other aspects of the subject. The rate at which the diagram paper traveled during the period occupied in making stops is such, when compared with the ordinates representing the coefficient of friction, that quite material variations in the ordinates are lost upon the eye in casual observation. If, however, the ordinates are platted upon a much more considerable scale, these variations become quite pronounced and produce an altogether different impression. Fig. 1 is a reproduction of the diagram illustrated in the Club paper as representative of a stop made from an initial speed of 60 miles per hour, the length of stop being 1898.5 ft. The more obvious vibrations of the recording pencil having been equalized and the ordinates carefully measured at uniform intervals, they are plotted in Fig. 2 on a scale 10 times as great as that of the original. In each case, the diagram begins at the right, from which distances are to be measured toward the left, the ordinates representing the coefficient of friction. Where one might superficially conclude from the appearance of Fig. 1 that the coefficient of friction is "nearly constant" during the greater part of the stop, such a conclusion hardly proves satisfactory after examining Fig. 2.

Fig. 2 satisfactorily illustrates the characteristic fluctuation of the coefficient of brake-shoe friction during a stop, even though it is somewhat obscured by the effect of many irregularities due to vibration or other accidental causes. It was discovered in the Westinghouse-Galton brake trials and clearly enunciated in Capt. Galton's reports. It is of high importance in assisting to explain the character of phenomena at variance with conclusions based upon the hypothesis that the coefficient of friction varies only with fluctuations of speed and pressure. The causes of each of the characteristic peculiarities of the friction line of stop diagrams will be separately discussed later on, but the peculiarities themselves may be advantageously distinguished and enumerated here. With the initial application of the brake shoe to the wheel, the friction line rises rapidly, but not instantly, to a maximum. It then begins immediately to fall back, in a curve convex toward the axis of distance, and after a moderate time reaches a minimum. It then gradually and continuously rises again until quite near the end of the stop, where the rise continues with greatly increased rapidity and terminates almost perpendicularly at a much greater height than at any previous point during its course. The course of the friction line may always be more or less modified at any point throughout the stop on account of accidental influences, which will also be discussed; but diagrams from the testing machine seem to be especially affected by vibration. Neglecting, for the present, consideration of the initial upward movement of the friction line, the immediate decline of the coefficient, after the initial maximum has been quickly attained, is a feature of most noteworthy significance. The pressure of the brake shoe upon the wheel is constant. From the first application of the shoe, frictional retardation immediately becomes effective and the speed at once begins to decline. Under these conditions, the coefficient of friction must at once begin to increase, even though slowly, unless some hitherto unconsidered influence causes the friction to decline more considerably than the falling speed causes it to increase. As the friction actually does decline and declines very considerably (except perhaps in cases where the initial speed is quite low), it is absolutely certain that the coefficient of friction is affected by some other influence than simply pressure and speed. Whatever that influence or combination of influences may be, it is distinctly such that it opposes, with varying degrees of effectiveness at different periods of the stop, the increase of the coefficient of friction due to the decline of the speed, and thereby results in a friction line which has been characterized in the Railway Club paper as "nearly constant."

The Effect of Continued Rubbing.

The fourth statement of the Club paper, that, at constant speed, "the coefficient of friction is practically a constant," when combined with the preceding considerations, presents a striking incongruity of conclusions. Understanding the influence of pressure to be eliminated, because the pressure is constant throughout, the three succeeding statements under consideration may thus be combined; first, the coefficient of friction varies inversely with the speed; second, during a continuous application of the brake shoe which results in a stop, while the decline of speed occurs through a wide range, the coefficient of friction does not correspondingly increase but remains "nearly constant" throughout the greater portion of the stop; yet, third, during a continuous application at constant speed, when there is no elevating influence upon the coefficient of friction through decline of speed, it again remains "practically a constant." It is manifest upon its face that these three conclusions express a combination of conditions which cannot coordinately exist. Some one of the three, at least, is distinctly in error. The first, the inverse influence of speed upon the coefficient of friction, may properly be dismissed as an established fact. The second, that, for some reason (unquestionably the operation of an unconsidered influence), the coefficient of friction does not continuously rise with the decline of speed during a stop, but, as crudely expressed, remains nearly constant during the greater part of the stop, is not only attested by the diagrams accompanying the Club paper, but was much more satisfactorily and fully established in the Westinghouse-Galton experiments. Inevitably, therefore, the third statement, to the effect that, at constant speed, the coefficient is "practically a constant," is the one which cannot be accepted. It requires no long search to discover the source of this misleading conclusion. The very next statement in the Club paper, succeeding the one already quoted, is as follows: "The curve representing the coefficient of friction does not, in the diagrams [of constant speed experiments], start at the axis of ordinates. The readings obtained at the beginning of an application are always more or less irregular, and were, therefore, omitted when plotting the curves." Here is the whole explanation in a nutshell. If the readings at the beginning of applications were occasionally "irregular," it were different; but the extreme regularity of these "irregularities," implied by the use of the word "always," leads directly to the inference that the omission to give them consideration is responsible for the unfortunate conclusion. The same sort of "irregularity" has been pointed out in our diagram of Fig. 2; it occurs in the diagrams of the experiments of others; and a careful analysis of the complete diagram curves, mentioned in the statement under consideration, would probably have resulted in the substitution of a more nearly correct conclusion, which may be stated somewhat as follows: In an application, during which a uniform speed is constantly maintained, the line representing the coefficient of friction rises quickly, but not instantly, to a maximum, and then immediately begins to decline, with continually decreasing rapidity, until it reaches a certain level, considerably below the initial maximum, at which it thereafter remains "practically a constant." As the matter stands, however, the substitute is now offered as the only rational conclusion to be drawn from the present state of our knowledge of the subject.

The Westinghouse-Galton experiments at different constantly maintained speeds clearly demonstrated that, after the initial maximum value of the coefficient of friction is attained (as indicated for various speeds at an unknown pressure, in the table produced above), it at once declines with a continually decreasing rate of rapidity. In the Galton reports, the decline was noted after consecutive uniform intervals of time. In attempting to formulate the law by which this decline occurs, it was first assumed by the present writer that it is a function of the time during which the shoe continues to rub upon the wheel. This resulted in obtaining a different law for each different speed, and a comparison of these laws quite clearly indicated that the decline is a function of the distance rather than the time through which the rubbing continues. Unfortunately, these constant speed experiments did not extend through a sufficient period of time to permit the decline of the coefficient of friction to be followed to a conclusion. Here also, the obstacle resulting from a failure to supply the record of the pressure of the brake shoe upon the wheel is again encountered. Thus no satisfactory determination of the law could be accomplished. But the fact that a decline of such a character actually takes place, was definitely established and its actual presence or evident effect is clearly manifest in all the stop diagrams then or since taken, so far as they have come within the observation of the writer. The experiments reported in the Railway Club paper appear to supplement the information given in the Galton reports with the additional fact that, after a limited period of continued rubbing (the limit itself being as yet wholly uncertain, in the absence of careful

examination of the early "irregularities"), the decline of the coefficient of friction practically ceases. Some views as to the cause of the limited decline will be hereafter advanced; but, for the present, it is sufficient to remark that, from any point of view, the limited character of the decline is rational. The fact that, after such a limited decline, the coefficient of friction remains constant, with constant speed, is useful as well as interesting, since it has an important bearing upon the efficiency of the brakes in controlling trains upon long grades. That operation of railroad train brakes which must be regarded as of controlling importance, however, is the one which occurs in bringing trains to a prompt stop, and however satisfactory it may be to know that, after the brakes have been applied for a quarter of a mile or more, the coefficient of friction remains practically constant, the question of much more real concern is, "how is it behaving during the first quarter of a mile?" We now simply know that, for some reason, the continued rubbing of the shoe upon the wheel through a very material distance (probably as great as that required for a stop from a speed of 60 miles per hour) is accompanied by an influence which depreciates the value of the coefficient of friction, and, regardless of the character of that influence, we need to very much more definitely know its actual effect.

From a joint examination and partial analysis of the published results of the Westinghouse-Galton experiments and of the stop diagrams accompanying the Railway Club paper, the writer has deduced a form of expression which seems to fairly represent the character of the depreciating influence due to continued rubbing. For the sake of its illustrative usefulness it is here submitted. Representing the initial maximum value of the coefficient of friction by f' (the expression for which has already been determined), if s represent the distance through which rubbing has continued since the initial maximum was attained, the coefficient of friction at that distance may be represented by the expression $f = \frac{1 + hs}{1 + cs} f'$ where h and c are algebraically positive constants. The values of the constants h and c, determined through such partial analysis of the meager information at hand, are $h = .0043$ and $c = .0056$. It may be assumed for the purpose of illustration, that, notwithstanding the variable character of f' (through the influence of the constantly declining speed during a stop), the effect of the depreciating influence of continued rubbing at any point during the stop, is the above formulated fractional portion of f', regardless of the actual value of f' at the instant. The value of f' already determined from the Westinghouse-Galton experiments may, by substituting for V (the speed in miles per hour) its value as a velocity, v, in feet per second, be written $f' = \frac{.326}{1 + .02408v}$, and when this expression is introduced into that for the value of the coefficient of friction after rubbing has continued through a distant s, the latter becomes $f = \frac{1 + .0043s}{1 + .0056s} \frac{.326}{1 + .02408v}$.

Now let P represent the pressure of the brake-shoe upon the wheel and let M represent the mass to be stopped by the retarding influence of the brake-shoe friction; then the retardation, or negative acceleration, of the mass at any period during the stop is $\frac{fP}{M}$ or $\frac{P}{M} \frac{1 + .0043s}{1 + .0056s} \frac{.326}{1 + .02408v}$, in which v and s represent respectively the velocity and the distance through which rubbing has occurred at that instant. If this retardation be substituted in the elementary differential equation connecting acceleration, distance and velocity, and the equation be then solved, it will be found that

$$.00803v^3 + .5v^2 = .00803v_1^3 + .5v_1^2 - \frac{P}{M}\left\{ .25032s + 31.1172 \log (1 + .0056s) \right\}$$

where v_1 is the initial velocity from which the stop is made and v is the velocity at the instant when any distance s has been traveled. While we do not know the actual brake-shoe pressure for which the maximum initial coefficient of friction may be represented by the expression $\frac{.326}{1 + .02408v}$, we may feel assured that there is such a definite pressure and we have only to attribute to M such a corresponding value that the ratio $\frac{P}{M}$ shall cause s to become 1900 when v_1 equals 88 (corresponding to a speed of 60 miles per hour) and v equals zero, in order to secure a diagram of a stop from a speed of 60 miles per hour. Whatever P and M may each actually be, it happens that when $\frac{P}{M} = 18.3623$, or when the brake-shoe pressure is about 57.1 per cent. of the weight to be stopped, the length of stop will be 1,900 ft. from an initial speed of 60 miles per hour. Applying this value of $\frac{P}{M}$ in the given equation representing the relation between v and s, it may, though a tedious operation, be solved for v when various different values are assigned to s. Corresponding values of v and s are then substituted in the expression for the value of the coefficient of friction and thus the values of the coefficient are determined for various consecutive points throughout the stop. In the absence of any definite knowledge of the law by which the small element of time is required to attain the initial maximum value of the coefficient of friction, that feature is necessarily ignored in a diagram constructed with the computed values of the coefficient of friction, and the matter has been treated as though the initial maximum were instantly attained. This introduces a slight error, which, however, does not impair the illustrative usefulness of the diagram. The diagram is as represented in Fig. 3.

Now compare Fig. 3 with Fig. 4, which is Fig. 2, and reduced to half size to economize space, with the addition of a dotted line suggesting the general character of the friction line if it were freed from vibrating influences. It is to be understood, of course, that no one of the values of the four constants a, b, h and c, employed in computing the values of the coefficient of friction of Fig. 3, may actually represent the conditions existing in the experiment which produced the diagram of Fig. 2—or its equivalent, Fig. 1; but the almost exact similarity of the fundamental characteristics of the two diagrams (Figs. 2 and 3) is strongly persuasive of the general correctness of the premises upon which Fig. 3 is constructed. It is safe to say that, with proper values of the four constants, Fig. 2 can be almost exactly reproduced (barring evident vibrations and irregularities) by this mathematical method of construction. In other words, the general correctness of the views expressed in regard to the character of the chief influences affecting the coefficient of friction, is mathematically as well as logically sustained.

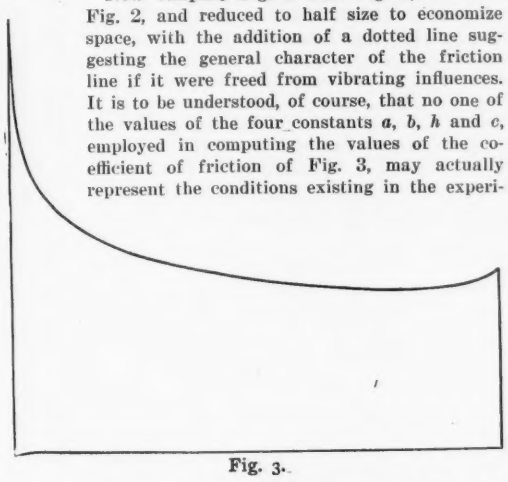


Fig. 3.

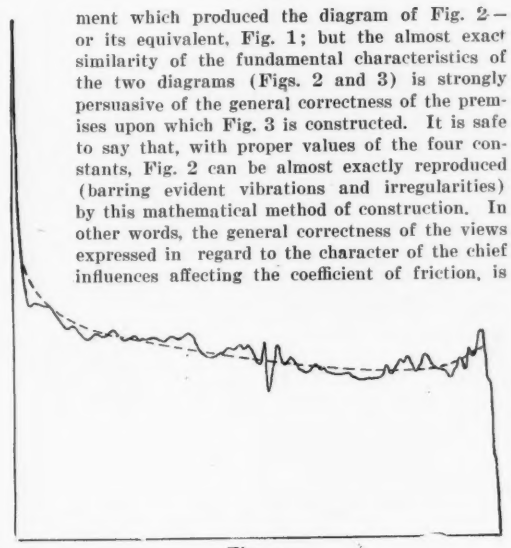


Fig. 4.

As an additional feature of interest, however, let it be assumed that the coefficient of friction is not subject to a depreciating influence as a result of continued rubbing of the brake shoe upon the wheel. The coefficient of friction at any time during the stop is $f = \frac{.326}{1 + .02408v}$ where v is the velocity at the instant. The mathematical relation between v and s will then be found in a similar way to be

$$.00803v^3 + .5v^2 = .00803v_1^3 + .5v_1^2 - 5.9861s,$$

in which the same value of the ratio $\frac{P}{M}$ (18.3623) is employed. Values of v are again found for different values of s and corresponding values of the coefficient of friction are determined. The resulting diagram is shown in Fig. 5, where for convenience of comparison, it is superposed upon the diagram of Fig. 3. The entirely different characters of the two diagrams is clearly apparent, the one last determined being the shorter one, subject only to a continuous, progressive rise of the friction line, which is not at all in accord with experimental diagrams.

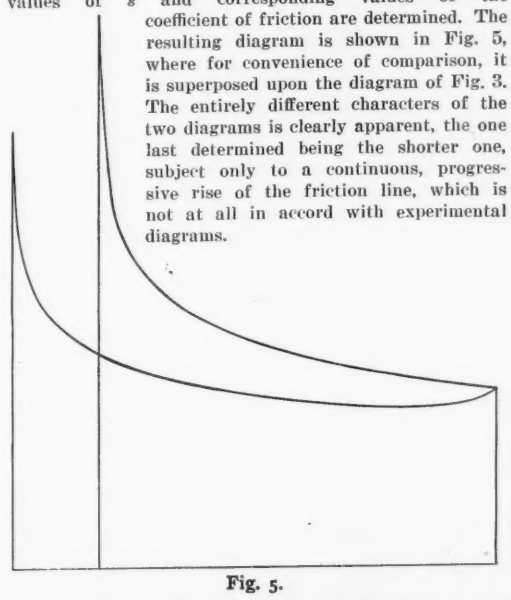


Fig. 5.

Of course, in stops from much lower initial speeds the friction line tends to rise much more rapidly, because the coefficient of friction increases much more considerably for a slight decrease of a low speed than for a similar decrease of a high speed, and it may thus easily occur that the depreciating effect of continued rubbing may be overbalanced by the appreciating influence of declining speed in stops from a low initial speed, so that, in such stops, the friction line might not actually drop below the initial maximum, but may merely remain stationary at first or even slowly rise; but, in *every* case, the friction line rises much less rapidly, and the length of stop is correspondingly greater, than would be the case if the depreciating influence of continued rubbing did not exist.

In the light of the understanding now reached, it may be made apparent why the mean coefficient of friction deduced from stop diagrams is not a reliable or desirable standard of reference or comparison. By reference to Fig. 5, it is seen that, if there were no depreciating influence at work during the stop, the stop would be a short one and the mean coefficient of friction correspondingly high. But, as there is such a depreciating influence, the coefficient of friction for each value of the declining speed is thereby reduced, and the extent of the reduction depends upon the distance traveled before each such value of the declining speed occurs. As a consequence, the longer the stop, with a given brake-shoe pressure, from any particular initial speed, the lower is the value of the mean coefficient of friction. It is true that, except for accidental causes of the variation of the coefficient of friction, in cases where the same mass is always stopped under the same initial speed and pressure conditions, as with the Master Car Builders' testing machine, the length of stop will not materially vary. But in actual practice, the ratio between the aggregate brake-shoe pressure and the mass of trains to be stopped, varies with each different length of train and weight of load (because of lack of uniformity in the breaking power of locomotives and cars), and the length of stop for a given brake-shoe pressure and initial speed may and does thus vary through a considerable range of distance. The influence of grades, also, has a similar effect in varying the length of stops. It will thus be apparent that the mean coefficient of friction, found for a given pressure and initial speed upon the testing machine, furnishes no reliable measure of the mean coefficient of friction during a train stop from the same initial speed with the same brake-shoe pressure, since the ratio of the net retarding force to the mass of the train varies greatly and, in more than 99 cases out of 100, is different from that of the testing machine. If the mean coefficient of friction has any utility as a standard of reference, it is only for comparing tests of brake shoes made upon the same testing machine. As there are other methods of making comparison of the frictional qualities of brake-shoes, which would appear to serve that purpose equally well and at the same time to contribute data of practical utility in a systematic investigation of the subject, it is to be hoped that the use of the mean coefficient of friction will be abandoned, as a means of comparison, in any future experiments relating to brake-shoe friction.

The Effect of Temperature.

The fifth essential statement of the Railway Club paper is that "the temperature of the rubbing surfaces does not affect the coefficient of friction." This statement is in reality coupled in the Club paper with the one last considered. The two have been distinguished, however, and treated separately in order that the question of temperature might be eliminated from the broader one (which, in the Club paper, was incidentally brought out in considering the subject of the effect of temperature) of the influence of continued rubbing upon the coefficient of friction. Since the significance of the omission to take cognizance of the character of the fluctuation of the coefficient of friction during the earliest period of rubbing in these tests, has already been sufficiently considered, the conclusion concerning the effect of temperature might be at once dismissed as wholly unjustified, were it not for the fact that the indicated temperature does not appear to have shown any material increase until after the rubbing had extended through about 1,000 feet. It is difficult to understand how this very fact could have failed to draw attention to the total incapacity of the temperature recording apparatus to furnish even a roughly approximate notion of the changes of temperature at the actual surface of the brake shoe. It is stated in the paper that, in the continuous runs at constant speed, the shoe and wheel were cold at the start, by which it is presumably meant that they were approximately in accord with the temperature of their surroundings. The diagrams illustrating the characteristic features of these tests are for a speed of 40 miles per hour and a brake-shoe pressure of about 2,800 lbs. One diagram shows that, at about 1,000 feet after the beginning of the application, the temperature had risen to only about 120 degrees, while at 2,000 feet the temperature had risen to 670 degrees. Another shows that, at the end of the first 1,000 feet of rubbing, the temperature had risen to only 90 degrees, while, at about 2,000 feet, it had risen to 520 degrees. A third shows that, at about 1,700 feet, the temperature had risen to but 185 degrees, while at about 3,500 feet it had risen to 665 degrees. The incongruity of such consecutive rates of the elevation of temperature of a surface subjected to such violent abrading friction ought to be instantly apparent. Any person so unfortunate as to have placed his hand upon a rapidly moving smooth surface or to have slid rapidly down a rope with only the resistance of the hand grip, has learned that, with even a comparatively light pressure and with little or no actual abrasion, a few feet of the rubbing suffices to raise the temperature above the boiling point. Any one who has observed the action of the brake shoes upon the wheels of a moving train can hardly have failed to notice that, very soon after the application, the flying particles of metal removed from the surface of the brake shoes are at such a high

temperature that they ignite and are oxidized as soon as they come into contact with the atmosphere. The highest rate of conductivity of any metal can be but slow in comparison with the speed at which the immediate rubbing surface of the brake shoe acquires temperature, where such a quantity of heat is generated in so short a time; and there can be but little doubt that, at the end of the first 1,000 feet of rubbing, the actual rubbing surface of the shoe, where the friction occurs, had, in each of the three cases cited, nearly approached the maximum temperature reached during the stop. In other words, the relative sluggishness of conduction through the short distance from the surface to the point at which the thermo-electric couple was located, combined perhaps with tardy response of the temperature-recording mechanism, resulted in inaccuracies of record of the temperature of the actual rubbing surface of the metal, which, during the early part of the application, must have amounted to hundreds of degrees—probably to a thousand. If temperature has any influence upon brake-shoe friction, it is the temperature of that portion of the metal that is actually subjected to the rubbing, and as these experiments furnish no information which can be considered of even remotely approximate reliability concerning the fluctuation of the coefficient of friction during the actual changes of temperature at the surface of the shoe, and as they do not even attempt to record either the coefficient of friction or the temperature during the period when the most important change of surface temperature inevitably occurs, no conclusions of any value can be drawn from them.

(To be Concluded.)

The Transmission of Heat Through Scale-Covered Boiler Tubes.

BY EDWARD C. SCHMIDT.

During the last three months there has been made, by the Railroad Mechanical Engineering Department of the University of Illinois, a series of experiments to determine the relative conductivities for heat of clean and scale-covered locomotive boiler flues. The tests were made by Mr. F. L. McCune, a member of the class of 1901, and the tables and figures given below are abstracted from his graduating thesis. The locomotive boiler tubes, upon which the experiments were made, were furnished by the Peoria & Eastern Division of the Cleveland, Cincinnati, Chicago & St. Louis, the Illinois Central, the Chicago, Burlington & Quincy, and the Chicago, Milwaukee & St. Paul. Table I gives information concerning the tubes themselves.

The apparatus used in these tests is shown in the engraving. It consisted essentially of a long water chamber through which the tube to be tested was passed, and in which water was circulated. On one end of this water chamber was fastened a combustion chamber, at the forward end of which was placed a burner. This burner was supplied with gas and air. Combustion took place in the chamber, which served the purpose of the locomotive fire-box. The hot gases passed through the boiler tube to the air. The water entered the water chamber at the right and left it at the left as indicated in the engraving, at both of which points its temperature was read upon the thermometers there shown. The water tank received the water from the city mains. It was provided with an overflow, as shown, and the water was led directly down from the bottom of this tank to the water chamber. This was used in order to give a constant pressure at the inlet and thus avoid variations in the rate of flow of the water. The gas and air tanks are arranged to give constant pressures of gas and air. The inner vessels, open at the bottom, float in water contained in the outer tank and confine the air or gas in the space above the water level. These inner tanks can be weighted at will to give any desired pressure to the air or gas contained within them. The copper ball of the copper ball pyrometer which was used to determine the temperature of the gases entering the flue, is plainly shown in the cut. The temperature of the gases as they left the flue was read on the thermometer shown at the end of the tube.

The purpose of the tests was to measure the number of heat units transmitted per hour through the different tubes. This was accomplished by weighing the water which circulated around the tube in the water chamber and measuring its rise in temperature. It was endeavored to maintain a constant furnace temperature at the entrance to the tubes throughout all experiments and thereby have available for transmission about the same amount of heat, since the amounts of gas and air supplied to the burner were continually the same. An average of ten experiments gave a gas consumption of 125.6 cu. ft. per hour and an air consumption of 842 cu. ft. per hour. The air was supplied to the burner under a pressure of 5⅜ in. of water.

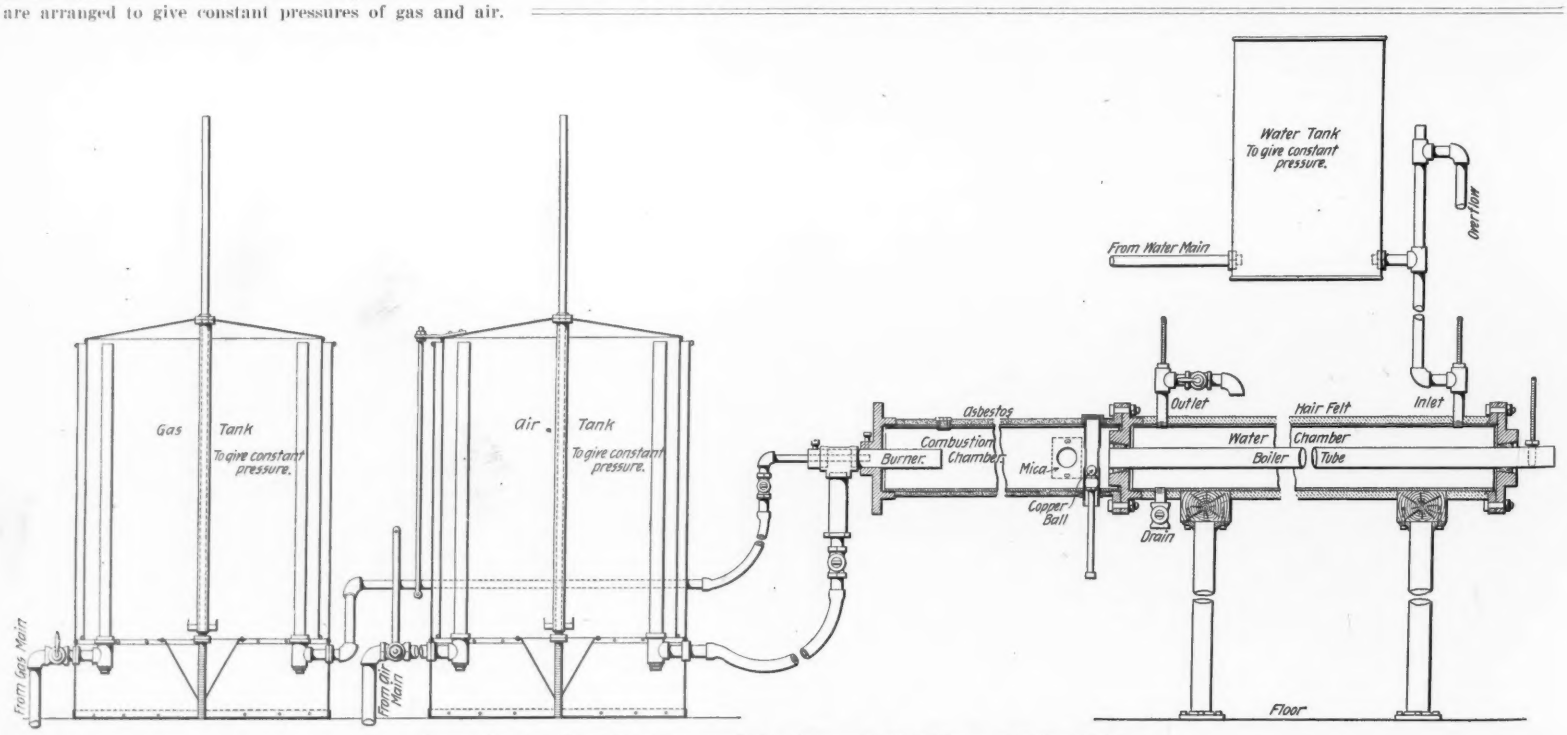
The method of conducting a test was as follows: The burner was first lighted and the gas and air pres-

TABLE I.—THE TRANSMISSION OF HEAT THROUGH SCALE-COVERED BOILER TUBES.

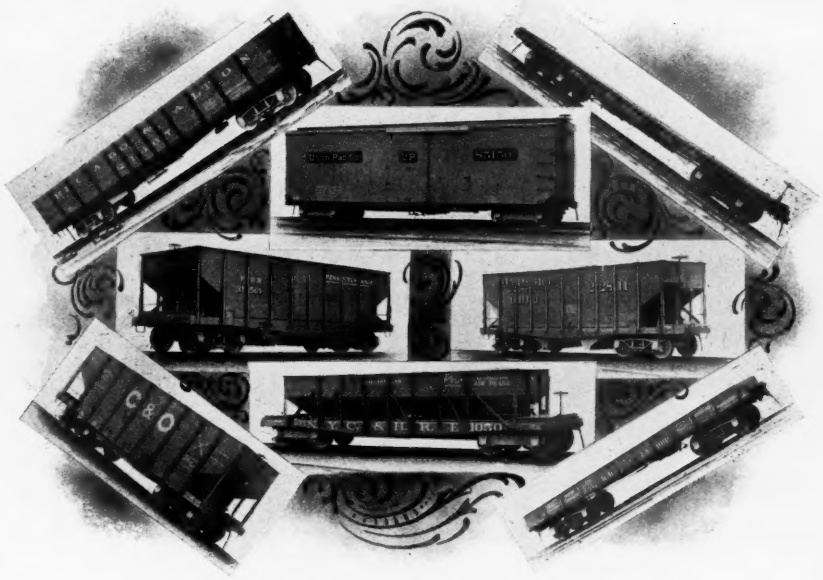
Tube Number.	Furnished By	Length of Time in Service, Months.	Diameters of Tube, Inches.		Average Thickness of Scale, Inches.	General Character of the Scale, Etc.
			Inside.	Outside.		
1	I. C. R. R.	10½	1.75	2.00	0.06	Even, hard, dense, mud-colored.
2	P. & E. Ry.	13½	1.75	2.00	0.04	Soft, porous, mud-colored, removed in places.
3	P. & E. Ry.	5½	1.75	2.00	0.02	Even, hard, dense, white.
4	C., M. & St. P.	....	1.75	2.00	0.03	Hard, dense, white.
5	C., M. & St. P.	....	1.75	2.00	0.13	Even, hard, dense, mud-colored.
6	I. C. R. R.	5½	1.75	2.00	0.07	Mileage during service, 19,690.
					0.04	Hard, dense and rough, one end; soft and porous at the other.
7	P. & E. Ry.	3½	1.75	2.00		
8	C., B. & Q.	....	2.25	2.50	0.013	Even, hard, dense, mileage 35,688, not tested.
9	C., B. & Q.	....	1.75	2.00	0.11	Hard, porous, gray; mileage 50,889.
					0.07	Soft, porous, mud-colored, mileage 42,190, not tested.
10	C., B. & Q.	....	2.00	2.25		
11	I. C. R. R.	21	1.75	2.00	0.09	Soft, porous.
12	C., M. & St. P.	54	....	....	....	Not tested.
13	C., M. & St. P.	30	....	....	....	Not tested.
14	P. & E. Ry.	....	1.75	2.00	....	New and clean tube.

TABLE II.—THE TRANSMISSION OF HEAT THROUGH SCALE-COVERED BOILER TUBES.

Tube Number.	Test Number.	Duration of Test, Hours.	Average Temperature during Tests, Degrees Fh.							Difference between Temperature of the Water and Temperature of the Gases, *i. e.*, Range of Temperature, Column 6, minus Column 9.	Weight of Water Used during the Test, Pounds.	B. T. U. Transmitted through the Tube during Test.	Averages for the Various Tests of Each Tube.			
			Of the Furnace Gases.			Of the Circulating Water.							Range of Temperatures, Averages from Column 11.	B. T. U. Transmitted through the Tube during the Tests, Averages from Column 13.	B. T. U. which would have been Transmitted had the Range of Temperature been the same as for Tube No. 14.	Decrease in the Conductivity due to the Scale— $\frac{29854-\text{Col. }16}{29854}\times 100$, Per Cents.
			In the Combustion Chamber.	Of the Escaping Gases.	Average Temperature of Gases.	At the Inlet.	At the Outlet.	Average Temperature of the Water.	Rise in Temperature of Water.							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2	16	1	1650	259.34	954.7	64.94	114.44	89.69	49.5	865.0	526.5	26062	859.4	27370	27816	6.82
	17	1	1616	259.52	937.8	64.85	110.12	87.49	45.3	850.3	650.5	29467				
	18	1	1631	269 2	950.1	64.14	110.3	87.22	46.16	862.9	584.0	26953				
	19	1	....	277.7	....	64.12	110.36	87.24	46.24	....	584.5	27027				
3	1	1	1693	239.18	966.1	64.65	110.39	87.52	45.73	878.6	593.5	27141	877.3	27258	27137	9.10
	2	1	1690	238.28	964.1	65.46	111.04	88.25	45.57	875.9	600.7	27374				
5	6	1	1559	247.64	903.3	65.76	110.62	88.19	44.85	815.1	583.0	26148	855.9	27270	27828	6.75
	22	1	1702	265.64	983.3	63.86	109.4	86.63	45.54	896.7	624.0	28416				
6	3	1	1682	263.3	972.6	65.3	110.39	87.85	45.09	884.8	685.5	30909	899.3	30675	29792	0.21
	23	1	1718	284.0	1001.0	63.68	110.82	87.24	47.12	913.8	646.0	30440				
7	8	1	1695	252.34	973.7	67.08	113.32	90.20	46.24	883.5	612.0	28299	886.5	29370	28936	3.07
	9	1	1693	256.1	974.6	66.88	111.92	89.40	45.04	885.1	669.5	30154				
	10	1	1704	250.34	977.2	63.86	108.77	86.32	44.91	890.9	683.8	30709				
9	4	1	1535	249.26	892.1	65.3	109.89	87.59	44.58	804.5	546.0	24341	820.8	23362	24859	16.73
	15	1	1597	252.32	924.7	65.75	111.04	88.40	45.3	836.3	505.0	22876				
11	7	1	1659	261.86	960.4	63.91	110.0	86.96	46.09	873.5	589.3	27160	882.2	26937	26680	10.63
	24	1	1683	272.12	977.6	64.15	109.4	86.78	45.24	890.8	590.5	26714				
14	5	1	1595	265.82	930.4	64.00	109.42	86.71	45.41	843.7	644.0	29244	873.4	29854	29854	Clean tube
	13	1	1690	266.9	978.5	67.82	113.94	90.88	46.1	887.6	650.2	29974				
	14	1	1693	267.62	980.3	68.54	114.26	91.40	45.7	888.9	664.0	30344				

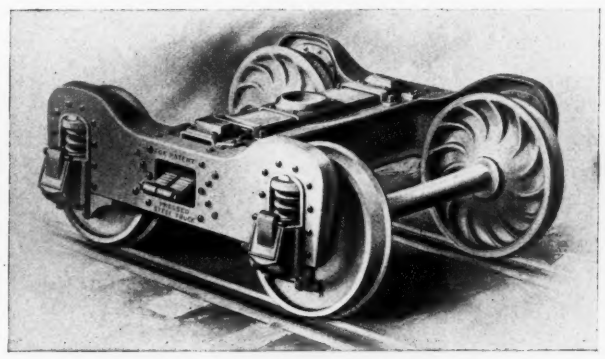


Apparatus to Show Heat Transmission Through Scale-Covered Boiler Tubes.



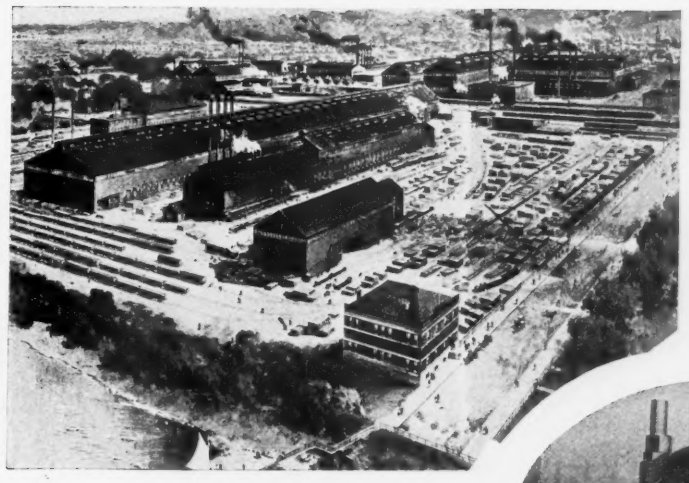
Types of Cars Now in Service.

Wreck Showing Results on Pressed Ste

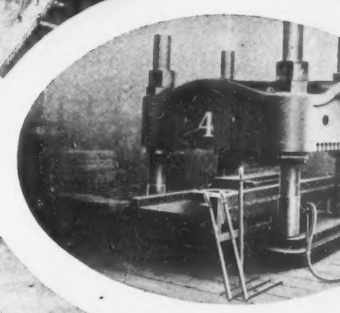


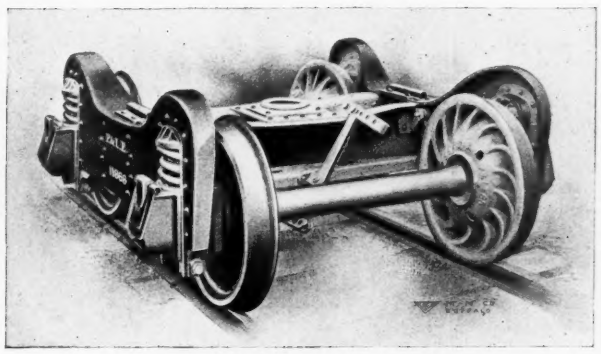
Pressed Steel Pedestal Tender Truck, With Elliptic Springs (Fox Patent).

Designed for 60,000, 80,000, *and* 100,000 *Pounds Capacity Tenders.*



Pittsburgh.



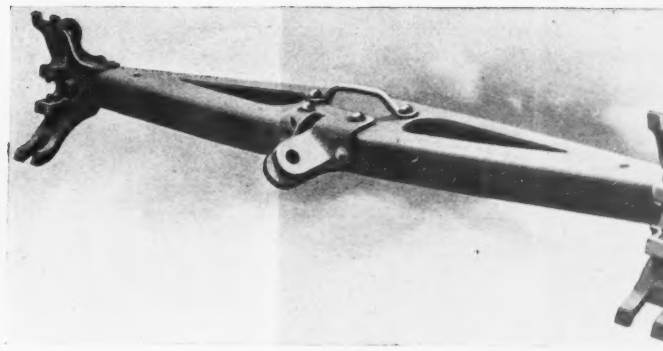


Pressed Steel Pedestal Truck (Fox Patent).

Designed for 60,000, 80,000, *and* 100,000 *Pounds Capacity Cars.*

Allegheny.

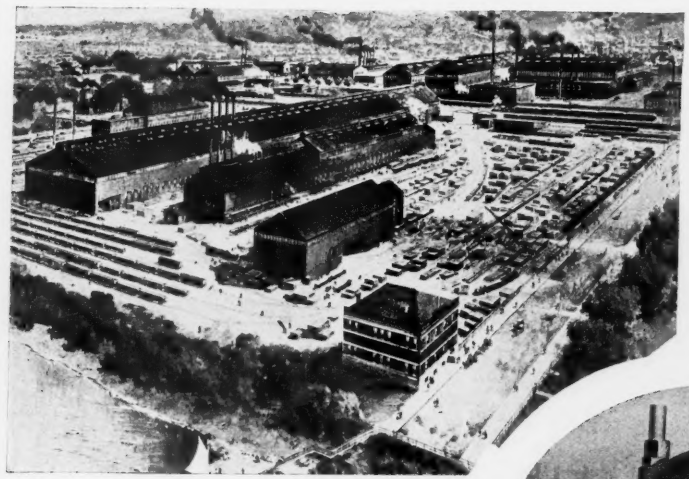
The Latest Type of Gondola Car.



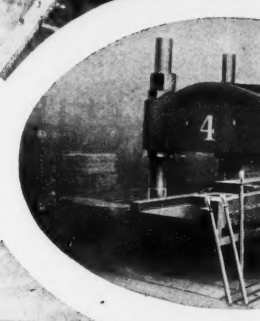
Solid Pressed Steel Brake-Beam.

THE WORKS AND SOME OF THE PRODUCTS OF THE

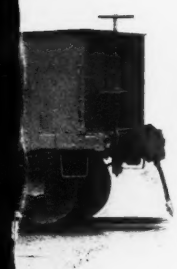
Wreck Showing Results on Pr

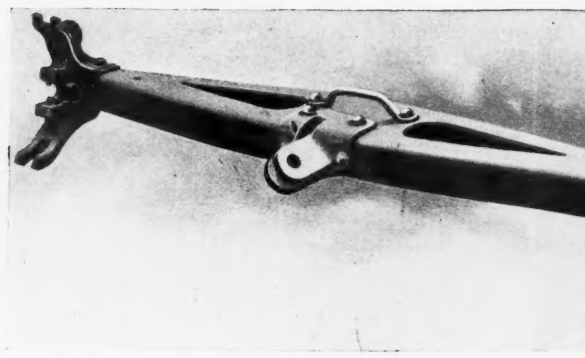


Pittsburgh.



Allegheny.

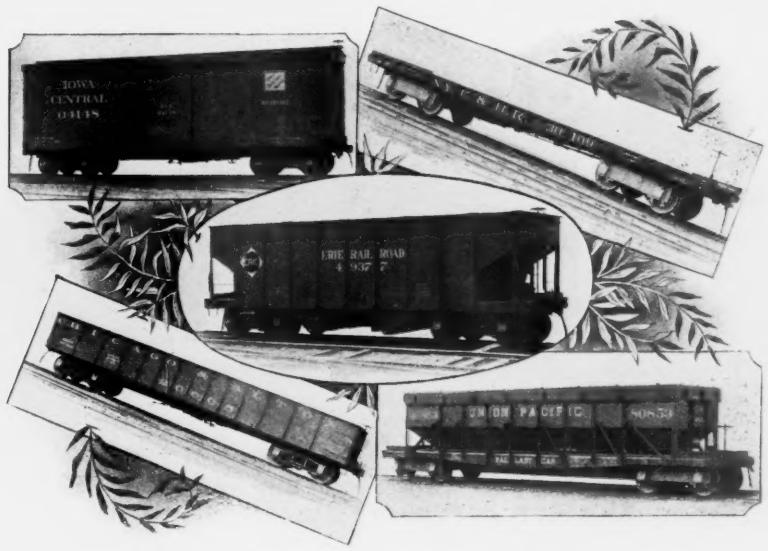




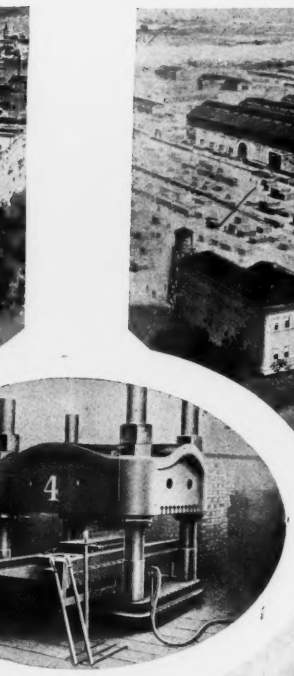
Solid Pressed Steel Brake-Beam.

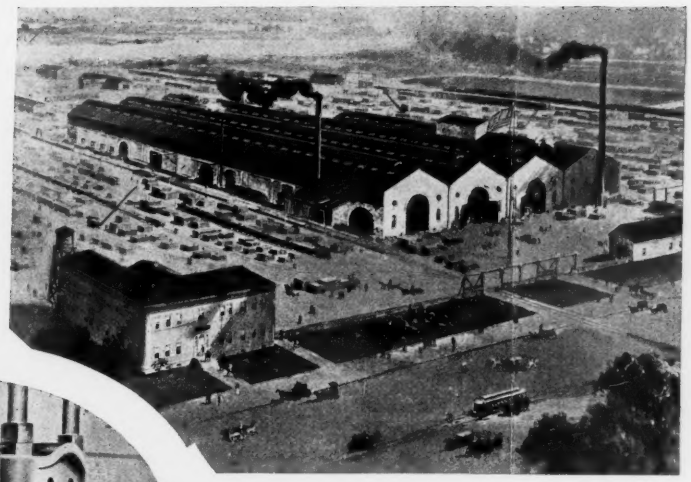
THE WORKS AND SOME OF THE PRODUCTS O

ults on Pressed Steel and Wooden Cars.

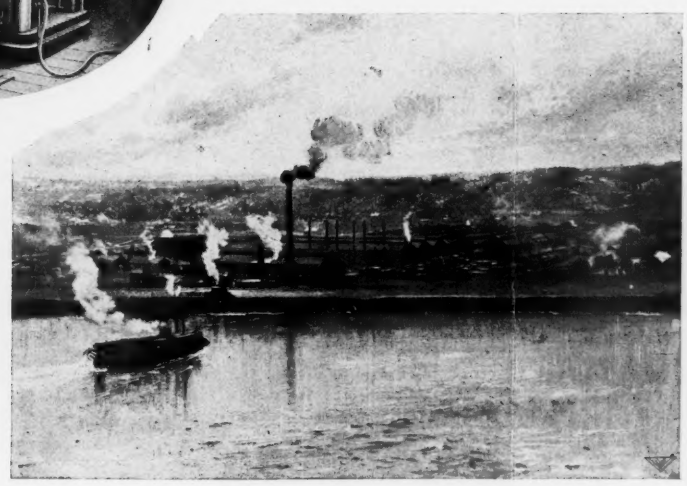


Types of Cars Now in Service.

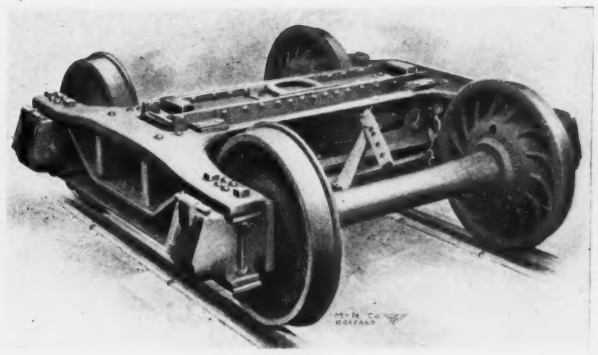




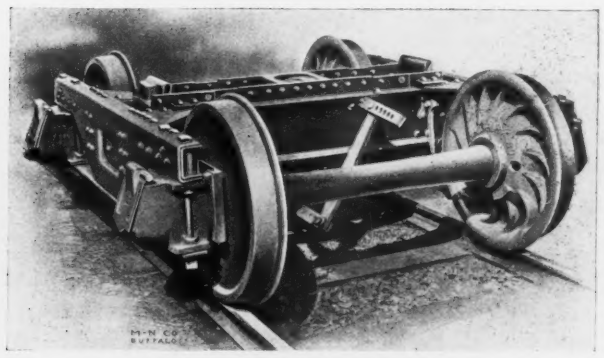
Joliet.



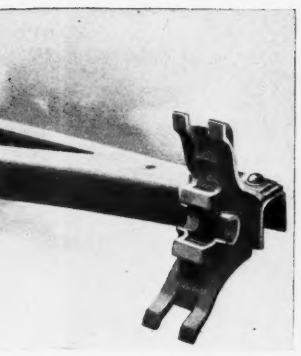
McKee's Rocks.



Pressed Steel Diamond Truck (Schoen Patent).
Designed for 60,000, 80,000, *and* 100,000 *Pounds Capacity Cars.*

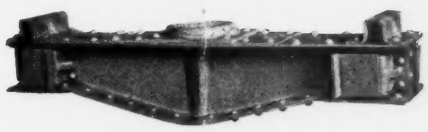


Buckeye Pressed Steel Diamond Truck.
Designed for 60,000, 80,000, *and* 100,000 *Pounds Capacity Cars.*

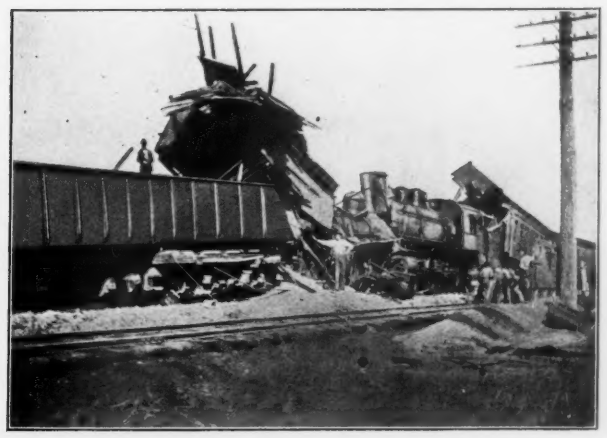


-Beam.

Type of Body Bolster.

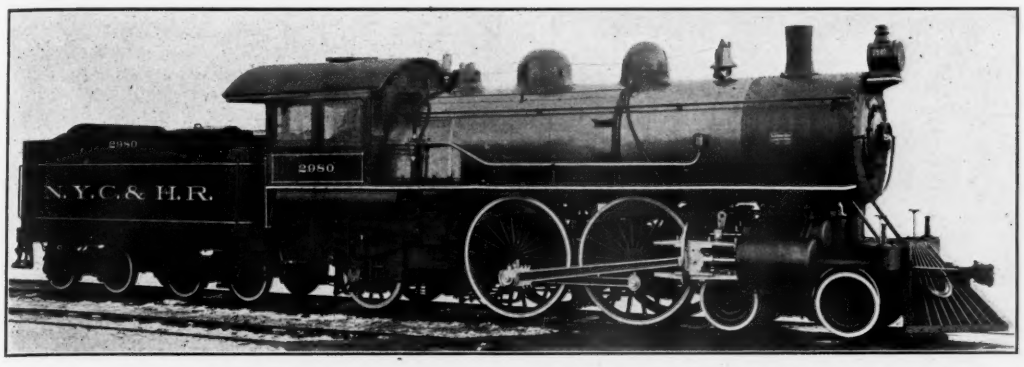


Type of Truck Bolster.



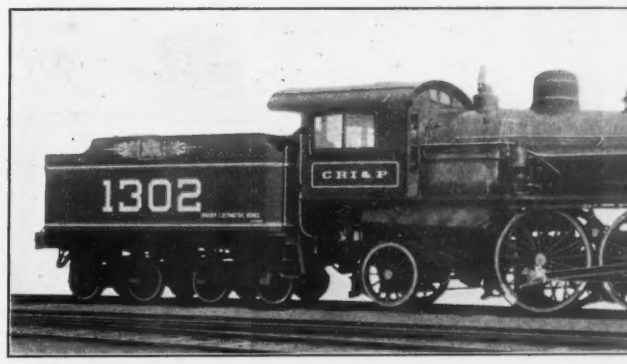
The Steel Car Is Here to Stay.

RODUCTS OF THE PRESSED STEEL CAR COMPANY.



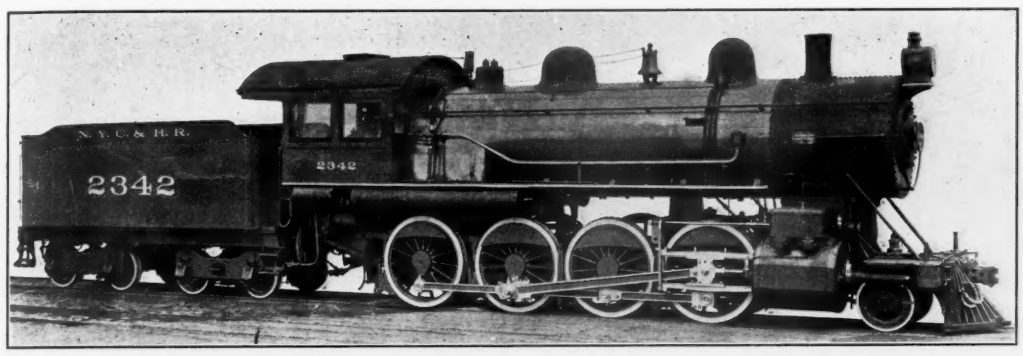
Schenectady Central-Atlantic Locomotive—No. 2980 New York Central.

Cylinders	21 x 26 in.
Driving wheels	79 in. diam.
Boiler	72 in. diam.
Fire-box	96⅛ in. long; 75⅝ in. wide
Heating surface	3,505 sq. ft.
Tubes	396; 2 in. O. D.; 16 ft. long
Grate area	50.32 sq. ft.
Driving wheel base	7 ft.
Engine wheel base	27 ft. 3 in.
Total wheel base	53 ft.
Weight on drivers	95,000 lbs.
Weight on trailing wheels	38,400 lbs.
Total weight of engine	176,000 lbs.
Fuel	Bituminous coal
Boiler pressure	200 lbs.



Brooks "Chautauqua" Type Passenger Locomotive—No. 1

Cylinders	20¼ x 26 in.
Driving wheels	78½ in. diam.
Boiler	66 in. diam.
Fire-box	108 in. long; 74 in. wide
Heating surface	2,806 sq. ft.
Tubes	322; 2 in. O. D.; 15 ft. 7¾ in. long
Grate area	55.7 sq. ft.
Driving wheel base	7 ft. 0 in.
Engine whe	
Total wheel	
Weight on	
Weight on t	
Total weight	
Fuel	
Boiler press	

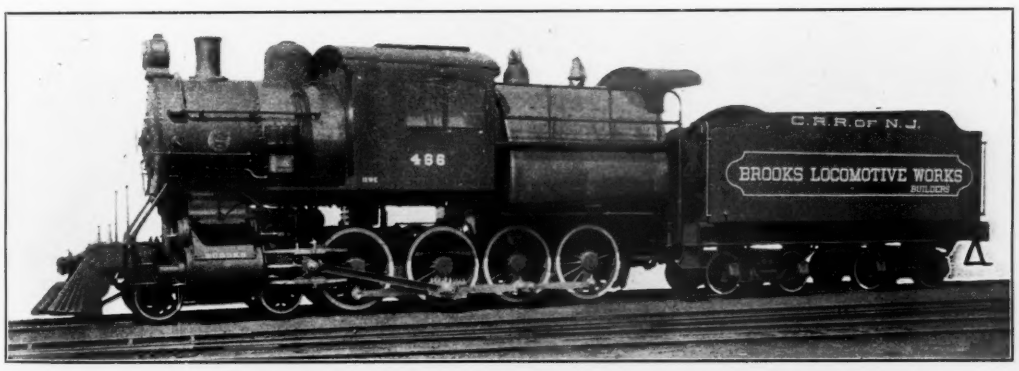


Schenectady Compound Consolidation Locomotive—No. 2342 New York Central.

Cylinders	23 & 35 x 32 in.
Driving wheels	63 in. diam.
Boiler	70 in. diam.
Fire-box	96 in. long; 75 in. wide
Heating surface	3,217.13 sq. ft.
Tubes	365; 2 in. O. D.; 16 ft. long
Grate area	50.31 sq. ft.
Driving wheel base	17 ft.
Engine wheel base	25 ft. 9 in.
Total wheel base	53 ft. 9 in.
Weight on drivers	164,000 lbs.
Total weight of engine	190,000 lbs.
Fuel	Bituminous coal
Boiler pressure	210 lbs.

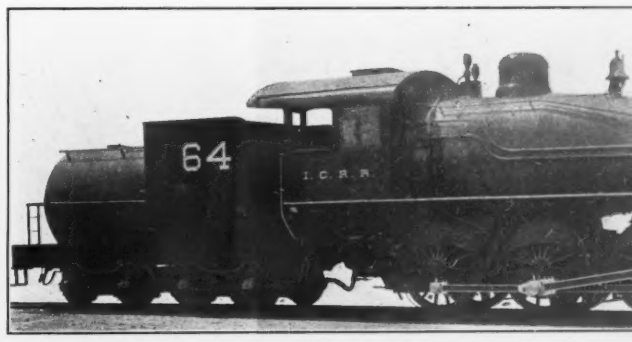
Baldwin Compound Consolidation Locomotive—N

Cylinders	17 & 28 x 30 in.
Driving wheels	55 in. diam.
Boiler	66 in. diam.
Fire-box	114¾ in. long; 95⅞ in. wide
Heating surface	2,968.7 sq. ft.
Tubes	356; 2 in. O. D.; 15 ft. 1 in. long
Grate area	76.33 sq. ft
Driving whe	
Engine whe	
Total wheel	
Weight on	
Total weight	
Fuel	
Boiler press	



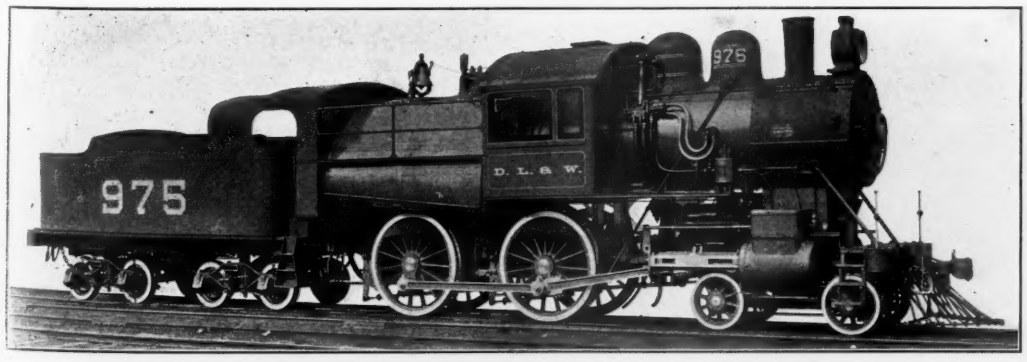
Brooks Twelve-Wheel Freight Locomotive—No. 466 Central Railroad of New Jersey.

Cylinders	20 x 32 in.
Driving wheels	55 in. diam.
Boiler	78 in. diam.
Fire-box	123 in. long; 77 in. wide
Heating surface	3,137 sq. ft.
Tubes	410; 2 in. O. D.; 13 ft. 10¼ in. long
Grate area	81.2 sq. ft.
Driving wheel base	15 ft. 0 in.
Engine wheel base	25 ft. 9 in.
Total wheel base	53 ft. 2½ in.
Weight on drivers	160,000 lbs.
Weight on front truck	42,000 lbs.
Total weight of engine	202,000 lbs.
Fuel	Fine Anthracite coal
Boiler pressure	200 lbs.



Baldwin Ten-Wheel Locomotive—No. 64 I

Cylinders	20 x 28 in.
Driving wheels	63 in. diam.
Boiler (Vanderbilt)	66 in. diam.
Fire-box (Cylindrical)	94 in. long; 57 in. wide at grates
External diameter of fire-box	63½ in.
Heating surface	2,497.5 sq. ft.
Tubes	350; 2 in. O. D.; 13 ft. long
Grate area	33 sq. ft.
Driving whe	
Engine whe	
Total wheel	
Weight on	
Total weight	
Fuel	
Boiler pressu	



Schenectady Eight-Wheel Locomotive—No. 975 Delaware, Lackawanna & Western.

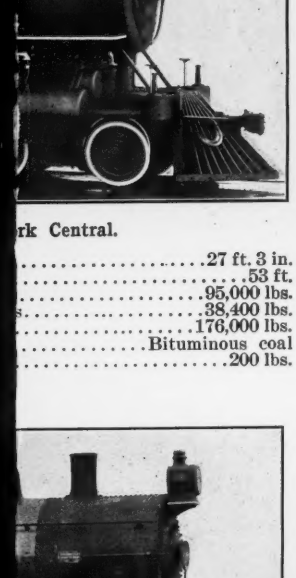
Cylinders	20 x 26 in.
Driving wheels	69 in. diam.
Boiler	61 in. diam.
Fire-box	126 in. long; 100 in. wide
Heating surface	2,143.27 sq. ft.
Tubes	280; 2 in. O. D.; 13 ft. 4½ in. long
Grate area	87.67 sq. ft.
Driving wheel base	8 ft. 6 in.
Engine wheel base	23 ft. 3 in.
Total wheel base	50 ft. 11¾ in.
Weight on drivers	93,000 lbs.
Total weight of engine	139,000 lbs.
Fuel	Low-grade Anthracite
Boiler pressure	185 lbs.

Baldwin Electric Locomotive—No. 26 Berwind-White Coal Mining Co.

Gage of track	3 ft.
Capacity	100 h.p. at 6 miles an hour on level
Full load drawbar pull on level	4,300 lbs.
Starting drawbar pull on level	5,200 lbs.
Height, exclusive of trolley	3 ft.
Width	4 ft. 8 in.
Length, excluding bumping blocks	12 ft. 2 in.
The controller is rheostatic.	
Driving wheels, diameter outside	30 in.
Journals	4 x 6 in.
Driving (and total) wheel base	4 ft. 8 in.
Weight on drivers (the total weight)	25,700 lbs.

SOME TYPICAL AMERICAN-BUILT LOCOMOTIVES EXHIBITED AT THE PAN-A

(Locomotives No. 975, No. 2,980 and No. 2,342 are not at Buffalo, but are repro



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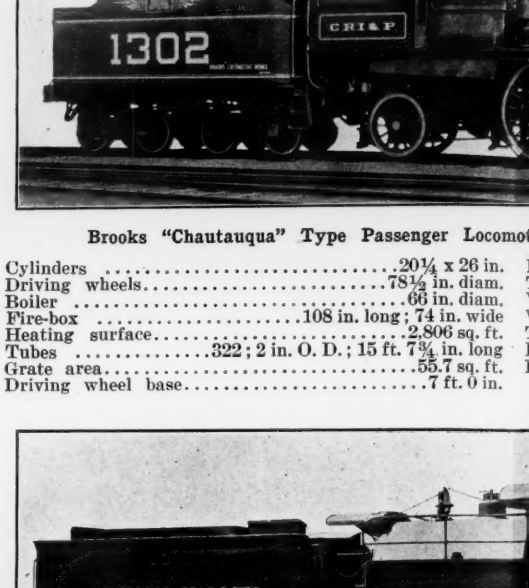
	27 ft. 3 in.
	53 ft.
	95,000 lbs.
s	38,400 lbs.
	176,000 lbs.
	Bituminous coal
	200 lbs.



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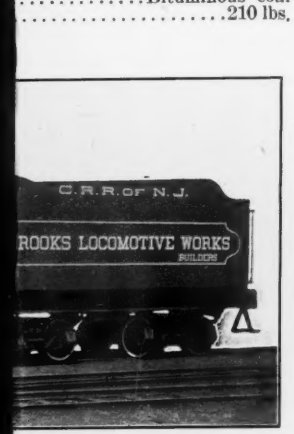
Grate area	55.7 sq. ft.
Driving wheel base	7 ft. 0 in.



York Central.

	17 ft.
	25 ft. 9 in.
	53 ft. 9 in.
	164,000 lbs.
	190,000 lbs.
	Bituminous coal
	210 lbs.

Baldwin Compound Consolidation Loc

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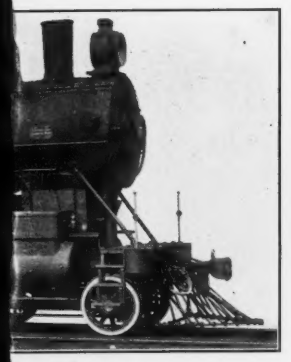

na & Western.

	8 ft. 6 in.
	23 ft. 3 in.
	50 ft. 11¾ in.
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	Low-grade Anthracite
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Starting drawbar pull on level	5,200 lbs.
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The controller is rheostatic.	
Driving wheels, diameter outside	30 in.
Journals	4 x 6 in.
Driving (and total) wheel base	4 ft. 8 in.
Weight on drivers (the total weight)	25,700 lbs.

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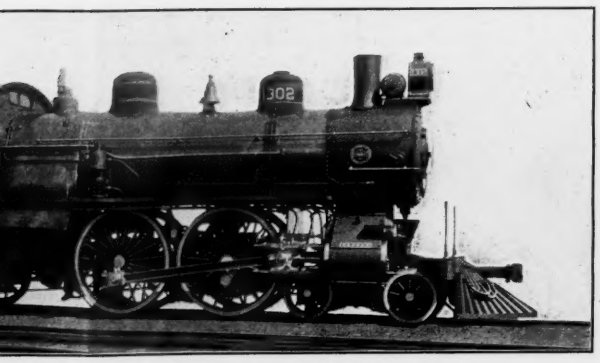
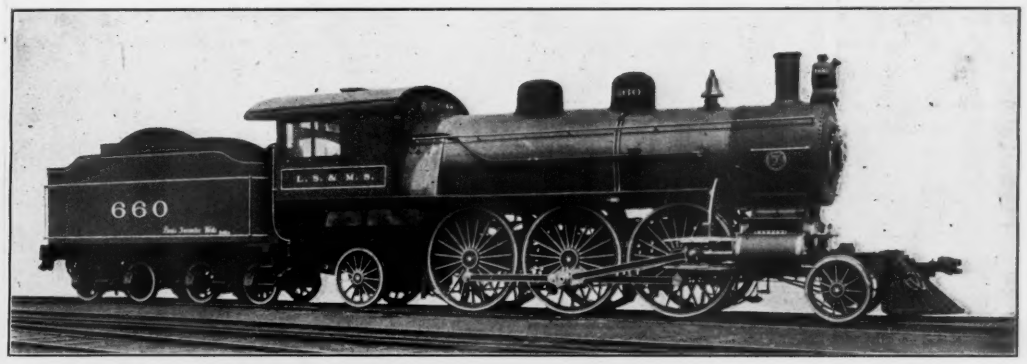


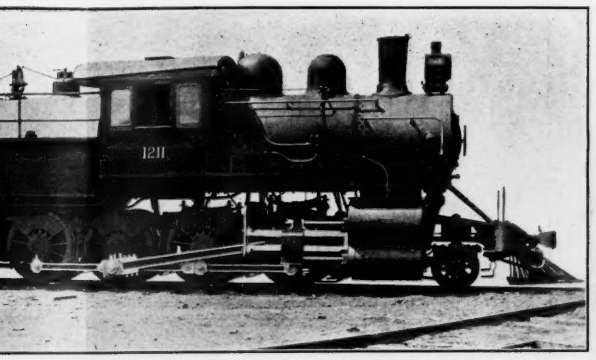
ger Locomotive—No. 1302 Chicago, Rock Island & Pacific.

¼ x 26 in.	Engine wheel base.....28 ft. 8 in.
in. diam.	Total wheel base.....53 ft. 7 in.
in. diam.	Weight on drivers.....93,500 lbs.
4 in. wide	Weight on trailing wheels.....37,000 lbs.
806 sq. ft.	Total weight of engine.....167,500 lbs.
¼ in. long	Fuel .....Bituminous coal
5.7 sq. ft.	Boiler pressure .....210 lbs.
7 ft. 0 in.	



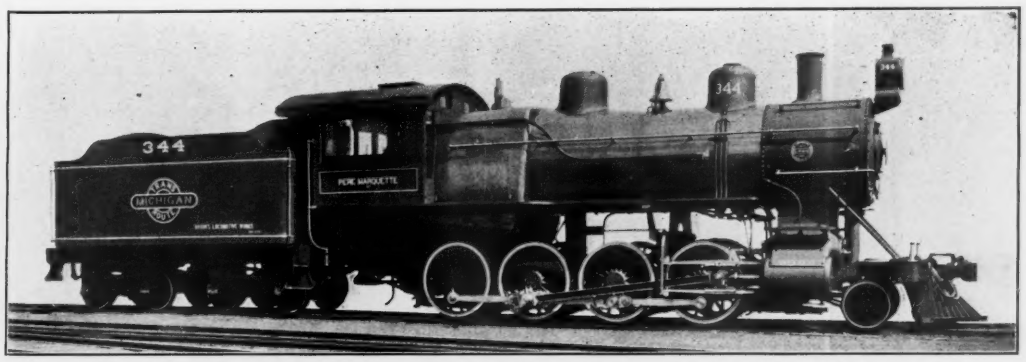
Brooks "Lake Shore" Type Passenger Locomotive—No. 660 Lake Shore & Michigan Southern.

Cylinders .....20½ x 28 in.	Engine wheel base.....31 ft. 9 in.
Driving wheels .....80 in. diam.	Total wheel base.....57 ft. 2¼ in.
Boiler .....66 in. diam.	Weight on drivers.....130,000 lbs.
Fire-box .....85 in. long; 84 in. wide	Weight on trailing wheels.....23,000 lbs.
Heating surface .....3,343 sq. ft.	Weight on front truck.....21,500 lbs.
Tubes .....285; 2¼ in. O. D.; 19 ft. 0 in. long	Total weight of engine.....174,500 lbs.
Grate area .....48.5 sq. ft.	Fuel .....Bituminous coal
Driving wheel base.....14 ft. 0 in.	Boiler pressure .....200 lbs.



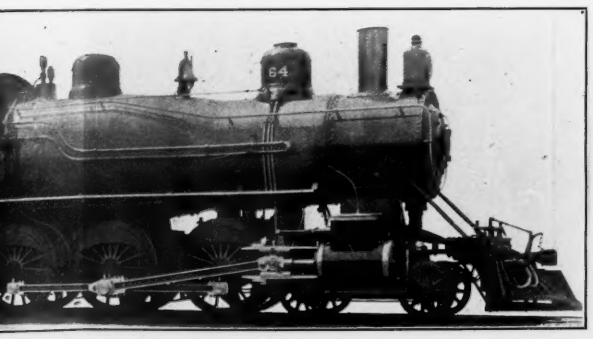
lidation Locomotive—No. 1211 Lehigh Valley.

8 x 30 in.	Driving wheel base.....16 ft. 3 in.
in. diam.	Engine wheel base.....25 ft. 5 in.
in. diam.	Total wheel base.....54 ft. 8⅝ in.
⅝ in. wide	Weight on drivers.....177,500 lbs.
8.7 sq. ft.	Total weight of engine.....202,200 lbs.
in. long	Fuel .....Anthracite coal
.33 sq. ft	Boiler pressure .....200 lbs.



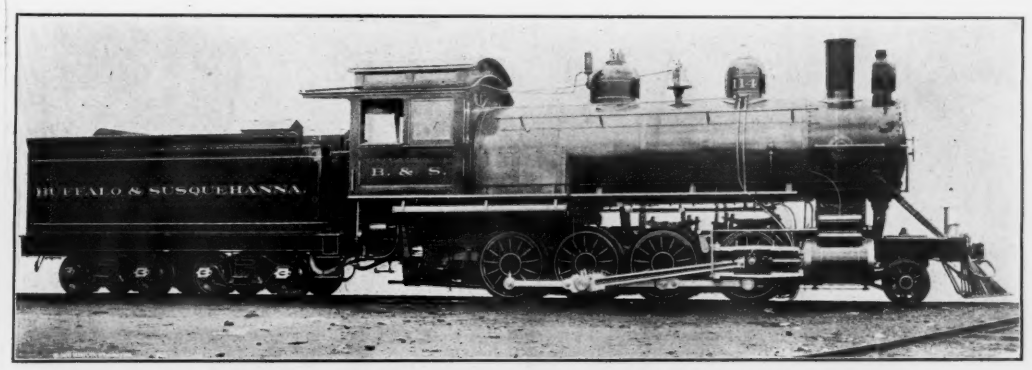
Brooks Consolidation Locomotive—No. 344 Pere Marquette.

Cylinders .....20 x 26 in.	Engine wheel base.....24 ft. 4 in.
Driving wheels .....56 in. diam.	Total wheel base.....52 ft. 9½ in.
Boiler .....66 in. diam.	Weight on drivers.....148,000 lbs.
Fire-box .....108 in. long; 74 in. wide	Weight on front truck.....15,000 lbs.
Heating surface .....2,470.5 sq. ft.	Total weight of engine.....163,000 lbs.
Tubes .....312; 2 in. O. D.; 13 ft. 10¼ in. long	Fuel .....Bituminous coal
Grate area .....55 sq. ft.	Boiler pressure .....210 lbs.
Driving wheel base.....15 ft. 6 in.	



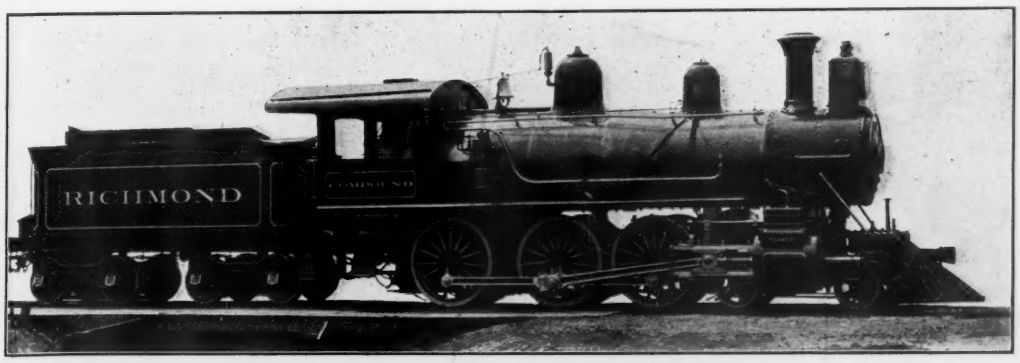
l Locomotive—No. 64 Illinois Central.

0 x 28 in.	Driving wheel base.....13 ft. 6 in.
in. diam.	Engine wheel base.....24 ft. 4 in.
in. diam.	Total wheel base.....53 ft. 3 in.
at grates	Weight on drivers.....137,040 lbs.
.63½ in.	Total weight of engine.....167,880 lbs.
7.5 sq. ft.	Fuel .....Bituminous coal
3 ft. long	Boiler pressure .....180 lbs.
.33 sq. ft.	



Baldwin Consolidation Locomotive—No. 114 Buffalo & Susquehanna.

Cylinders .....22 x 26 in.	Driving wheel base.....13 ft. 8 in.
Driving wheels .....51 in. diam.	Engine wheel base.....22 ft.
Boiler .....66 in. diam.	Total wheel base.....50 ft. 8 in.
Fire-box .....113⅞ in. long; 66 in. wide	Weight on drivers.....139,140 lbs.
Heating surface .....2,282 sq. ft.	Total weight of engine.....154,485 lbs.
Tubes .....304; 2 in. O. D.; 13 ft. 6 in. long	Fuel .....Bituminous coal
Grate area .....52 sq. ft.	Boiler pressure .....200 lbs.



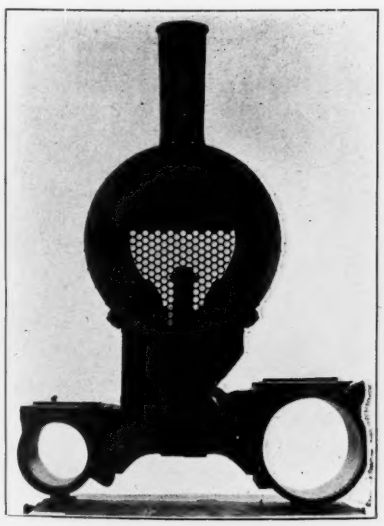
The Richmond "Tramp" Compound Locomotive, No. 2427.

Cylinders .....20 & 32 x 26 in.	Driving wheel base .....12 ft. 4 in.
Driving wheels .....62 in. diam.	Total wheel base, engine and tender.....50 ft. 1⅛ in.
Boiler .....60 in. diam.	Weight on drivers.....109,000 lbs.
Fire-box .....108 in. long; 41⅞ in. wide	Total weight of engine.....145,900 lbs.
Heating surface .....1,964.8 sq. ft.	Fuel .....Bituminous coal
Tubes .....256; 2 in. O. D.; 13 ft. 5¼ in. long	Boiler pressure .....200 lbs.
Grate area .....31.4 sq. ft.	

d-White

.....3 ft.
r on level
4,300 lbs.
5,200 lbs.
.....3 ft.
4 in. 8 in.
2 ⅝, 2 in.

.....30 in.
.4 x 6 in.
4 in. 8 in.
5,700 lbs.



Richmond—No. 2427.

TED AT THE PAN-AMERICAN EXPOSITION, BUFFALO, N. Y., U. S. A., 1901.

Buffalo, but are represented by Locomotives of their Respective Classes.)

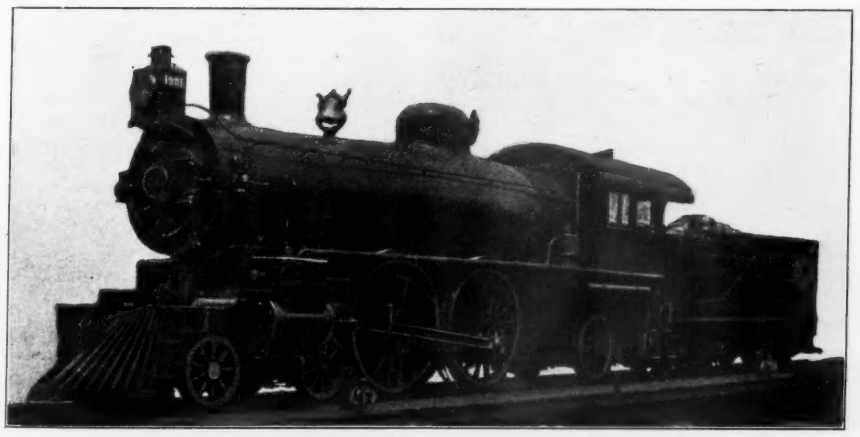
sures adjusted, then the flow of water through the water chamber was regulated and the apparatus allowed to run until all conditions had become uniform. This usually occupied about one hour, at the end of which time the test was started. At the beginning of the test a determination of temperature was made by the copper ball pyrometer and readings were taken on all three thermometers, which readings were also taken at intervals of 5 minutes throughout the test. At the end, another determination was made of the temperature and the water which had flowed through the chamber was weighed.

Table II gives a summary of the data of the various tests and also the calculated results. In spite of the efforts to keep it so, the furnace temperature was not maintained quite the same throughout the tests, as an inspection of Table II will show. It was likewise impossible to maintain the average temperature of the circulating water the same during all the tests. Consequently the range of temperature between the gases in the tube and the water varied somewhat. Since the rate of transmission of heat through the tube varies directly with this range in temperature it is necessary, in order to compare the conductivity of the different tubes, to reduce the actual amounts of heat transmitted to what they would have been for one standard range of temperature. This standard range was assumed the same as the range existing during the test of the new clean tube No. 14. These derived figures are given in column 16, Table II, and they show the amounts of heat which would have been transmitted in each case had the difference between the temperature of the gases and the temperature of the water been the same in all tests, i. e., the same as during the tests of tube No. 14. It is from the figures in this column that the losses due to scale are computed.

The experiments are not yet numerous enough to permit of any general conclusions being drawn from them, and they are presented at this time merely to show what the heat loss may amount to in individual cases and to indicate also how widely this loss varies with different sorts of scale. It is the intention to continue these experiments and to accumulate enough data to warrant some general conclusions concerning the relations existing between conductivity and the thickness, hardness and other physical and chemical properties of the scale.

The New Class E-2 Locomotive—Pennsylvania Railroad.

The accompanying illustration shows the latest passenger engine of a number being built by the Pennsylvania Railroad Company, at the Juniata Shops at Altoona. The absence of unsightly pipes gives the boiler a clean appearance, and the design shows advance in



New Class E-2 Passenger Locomotive—Pennsylvania.

locomotive building. It will be seen that it is developed from the earlier class E-2 which was brought out last year, and illustrated in the *Railroad Gazette*, pages 492 and 605, 1900. The best features of that engine, together with certain details of the class D 16-d are embodied in the new engine.

This engine has some innovations, particular attention having been given to the comfort and convenience of the enginemen. The injectors are placed on the back head within easy reach of either the engineman or fireman, and either injector can be put to work without the men rising from their seat. The injector branch pipes enter the back head and deliver the water approximately at the same point as with the use of the ordinary outside boiler checks. A No. 11½ automatic restarting Sellers injector is used on the right side, and a No. 11 Simplex restarting Monitor injector on the left side. The sandbox is built up around the steam dome, forming an elliptical-shaped casing, the major axis being parallel with the boiler. This arrangement keeps the sand dry and gives a very neat appearance.

Steel is largely used in the construction. The cylinders are cast separate from the saddle and secured by driven bolts. One of these engines, No. 1,983, hauled train No. 21 from Jersey City to Philadelphia, May 31, the running time, with one stop, being 2 hours and 3 minutes, and the distance 90 miles. The train left Jersey City 14 minutes late and arrived at Broad street station, Philadelphia, on time, without any special effort on the part of the engine. The weight of the train, not including engine and passengers, was 250 tons. The tractive power, according to the Master Mechanic's formula, is 22,400 lbs. Some of the important dimensions are as follows:

Boiler, Belpaire, wide fire-box type.	
Boiler pressure, pounds per square inch	205
Diameter of driving wheels	80 in.
Cylinders	20½ x 26 in.
Travel of valve, maximum	7 in.
Outside lap of valve	1½ in.
Total wheel base, including tender	60 ft. 1 13-16 in.
Total grate area	55.5 sq. ft.
Total heating surface	2,640 sq. ft.
Length of flues	15 ft.
Diameter of flues	2 in.

The Steam Features of Electrical Power House Design.

BY F. W. DEAN.

The design of power houses for the generation of electricity for electrically worked railroads for various reasons is occasionally undertaken by steam railroad companies. The consideration of certain features of such plants will be undertaken in the following article.

The first question to be considered is the boiler plant. Anybody taking this up will be strongly pressed by the makers of water-tube boilers, who will argue that safety and economy demand the use of such boilers, especially if high steam pressure is to be employed. They will point out that many horizontal return tubular boilers have exploded and that many others are on the point of exploding. It should be borne in mind, however, that no explosions of such boilers have occurred except those made with lap joints for the longitudinal seams, and that the reason therefor is fully understood. It is simply that the lap joint throws the shell out of round, that pressure tends to make it round, and that changes in pressure bend the plate at the edge of the lap and finally crack it. I know of several cases where progressive cracks of this kind have caused warning leaks. Steam drums of water-tube boilers have in many cases been made with lap joints and are likely to cause explosions. I know of one case where the crack at the edge of the lap on this drum of a water-tube boiler was discovered by subjecting the drum to hydrostatic test pressure. The drum opened and showed that the plate had been all but cracked through near the edge of the lap.

There have been some disastrous explosions of water-tube boilers and explosions of tubes are of almost daily occurrence. Tube explosions are of such frequent occurrence that one can hardly feel safe in being near a water-tube boiler. Records that I know of show that the explosions of water-tube boilers are twenty-five times as frequent as those of horizontal return tubular boilers.

My object in briefly dwelling upon the safety features of the two great divisions of boilers is to show that the matter is not all one-sided, and in fact that the horizontal return tubular boiler with butt longitudinal joints has the better record for safety.

Now in regard to economy if we consider the fact that it is impossible to cause hot gases to sweep over all parts of the tubes of water-tube boilers, that tiles may be displaced and thus allow gases to short circuit, that where tiles rest upon tubes that are nearly horizontal they soon encrust those tubes and render them nearly useless, that where the gases impinge upon tubes they cause a triangular accumulation of soot and debris, and that the heating surface of the tubes cannot be cleaned, it would seem as if no further argument is needed to show that a type of boiler in which these conditions and effects seldom occur, as, for example, any of the usual forms of fire-tube boilers, is the more economical.

I know of a large street railroad plant where there are enough water-tube boilers to properly run the engines and also enough horizontal return tubular boilers therefor. Repeated trials of a week's duration each, first with one kind and then with the other, show that the saving by the use of the fire-tube boilers amounts to from 12 to 15 per cent. of coal. This in money means a saving of about $100 per week.

If it is high pressure that is to be considered, the higher the pressure the more dangerous from tube explosions the water-tube boiler becomes, and in some of them the design unfits them for high pressure, while with fire-tube boilers there is no evidence that high pressure has caused a single explosion.

If it is bad water that is encountered, this is bad for either type of boiler. It sometimes fills water-tubes solid full of deposit and in fire-tube boilers it accumulates on the outsides of the tubes and on the bottoms of shells. It can be made to deposit it in a drum below a fire-tube boiler as well as in a drum of a water-tube boiler, and this is done in many cases. There are purifiers that with attention are effective, and they should be carefully investigated by any engineer who encounters bad water.

If it is a question of the forcing capabilities of boilers, the fire-tube boiler is superior to the water-tube, as in the former case the heating surfaces are more effective since they are more fully used and are cleaner. I can give ample proof of this from actual trials. It is, in fact, unnecessary to tell a steam railroad man that he has hundreds of fire-tube boilers under his care that are forced at such rates that all other cases of forcing are utterly insignificant. He knows that the reason they are forced is that they have a strong draft and that that will force any boiler.

From these and other considerations I have never found myself able to advise the use of water-tube boilers.

Vertical fire-tube boilers will be found somewhat more economical than horizontal return tubulars, and where land is scarce or expensive they are advantageous, as by their use twice as much power can be obtained from a given floor space as with horizontal boilers of any usual type. Vertical fire-tube boilers should not, however, be used with water that is very bad unless a successful purifier is installed, as the tubes are sure to leak at the lower ends.

People seldom realize how important it is to take the greatest pains to have tight brickwork around externally-fired boilers. Good foundations that will not settle and the very best brick laying are necessary. The condition of the brickwork can be best tested by gas analysis. I know of a plant where iron flues and brick flues are both used. At the end of the former the CO_2 averages 12 per cent. and at the end of the latter only 6 per cent. This is known to be caused by air leaks, as all other conditions are alike.

Economizers in smoke flues in large plants are worth having, but in small plants, while they will save a proper percentage the actual saving may not be sufficient to make them worth the bother of taking care of and maintaining them. Here again tight brickwork is very important, both about the economizer and the boilers. It gives an economizer no kind of an opportunity to do itself justice if it does not receive the hottest gases. Flue connections, smoke-box doors and dampers should be made tight, and they very seldom are. Sheet-iron sides stuffed with a good non-conductor instead of brickwork are desirable for economizer sides.

Induced artificial draft is considerably used nowadays, and I am inclined to favor it on account of the facility with which a strong draft can be obtained. From occasional experience I am inclined to think that there is fully as much economy in fuel in forcing boilers that are proportioned for it as in running them at low power. Gas analyses are certainly as good or better, and as an investment there can be no question as to the advantage of the hard driven plant. Some means of duplicate draft should be provided. Low chimneys should not, however, be called an advantage of induced draft, for experience frequently shows that dust from low stacks is intolerable, to say nothing of low area of smoke. If rapid combustion is to be employed firemen must be schooled to it.

To promote economy an econometer for continuously indicating CO_2 in the escaping gases is a good thing, but in a plant where there is no chemist to check it with occasional analysis and to keep it in order it is of very little value.

I believe in large boiler units for large plants. They are cheaper, more economical, require less piping for steam, feed and blow-offs, fewer valves for all purposes, fewer flues and dampers, less pipe covering and fewer firemen. Yet one occasionally sees large plants made up of small units.

Engines are often somewhat embarrassing on account of the multiplicity of makers of good types with which one finds himself surrounded without any effort of his own. Electric demands have caused weights to be very much increased in all parts and bearings to be enlarged beyond dimensions formerly used in most work. For hoisting at mines and in rolling mills the conditions have been for years fully as exacting as in street railroad work. The fear in driving generators is that short circuiting may throw great resistances on engines very suddenly, but a large ingot entering between the rolls of a rolling mill must be fully as bad, or suddenly throwing the load on a constant working mine hoisting engine by means of a power friction clutch.

In selecting engines for electric work the engineer should look out for large sizes, heavy weights, tight valves and pistons and independent motions to the steam and exhaust valves. Valve seats that are held down with set screws should be looked upon with suspicion. They probably always leak. Corliss valves can be properly seated on the iron of the cylinder casting, but gridiron valves need false seats which make a scraped joint with the cylinder casting, and should be held down by many countersunk screws. Piston valves should always be looked upon with suspicion.

A very few years ago a large piston of a horizontal cylinder was almost sure to be so troublesome as to be avoided and vertical engines were almost necessary.

The simple expedient of placing babbitt metal or composition in the underside of horizontal working pistons has worked wonders, and the necessity of vertical engines has somewhat receded.

It is common to pipe live steam to low pressure cylinders of compound engines and to interpose a reducing valve in the pipe. There are several good reducing valves and this feature of piping may often keep a plant in operation.

Electric demands for lighting and some other uses have spurred engine builders to perfect governing mechanism, and the application of the Rites governor both to high and low-speed engines has left but little to be desired in this respect. Any sensitive frictionless governor, however, will, unless possessing gross defects in design, perform the work sufficiently well. High-speed centrifugal governors have but very little power, and the frictionless quality is therefore of the greatest importance. This is entirely neutralized by tight fits, and every fit on a governor should be very loose, even at the risk of the maker being charged with doing a poor job of fitting. Ball bearings are used to some extent on engine governors and are good things. A type of governor which has no resistance to overcome but which is nevertheless strong enough to set a powerful secondary piece of mechanism in operation which can work quickly is an ideal arrangement. Such are Leavitt's hydraulic governor and the Lombard water-wheel governor, which has been applied to a few engines. Charles T. Porter's governor, as applied to the Porter-Allen engine, is a good example of a high-speed sensitive governor.

The parallel working of two or more engines with alternating electric generators upon their shafts apparently made almost impossible demands upon the governing capacities of engines, and many computations of the proper weights of flywheels to secure this end have been made and as it seems uselessly. It has been found that if two or more engines are once put into "step" it is impossible to get them out, even if steam is shut off from one of them. In such a case the work is taken by the other engines, the generator of the dead engine becomes motorized and continues its speed. It can only be stopped by throwing the switch of its generator. It is advantageous with engines working in parallel to have an electro-magnetic attachment to the governor for influencing the speed when starting so as to have it exactly right before throwing in the switch.

There has been a good deal of fear for the safety of flywheels. I think this is unnecessary in considering designs, for so far as I know, breakages have been confined to old wheels of inferior design. A wheel should have depth of rim sufficient for it to act as a well-proportioned girder, and the segments should be fastened together so as to have no weak point. The strength is a mathematical problem of exact solution and then if the material is sound, safety results. Cast iron is amply safe for flywheels as the strain per sq. in. at all common velocities is very small. If one is not satisfied with cast iron cast steel is certainly safe. It is my belief that the great expense of some recent elaborately built-up wrought iron or wrought steel flywheels is not justifiable. For direct-connected generators it has long seemed a mistake to add a flywheel, as generators could easily be made heavy enough to give all needed flywheel effect. This has finally been done and the first installation of such will be in the Manhattan Railroad power house. There is no fixed limit to flywheel rim velocity, and it should be considered on its merits in each case.

Engines with disengaging valve gears are often thought to have limits in speed which are not much above 100 revolutions per minute, but there are a sufficient number of exceptions to this to show that the limit is farther off. A well-known Corliss engine with 40-in. stroke at the Trenton Iron Works has been running for years at from 160 to 190 revolutions per minute. On the recommendation of Dean & Main, a Corliss engine with 36-in. stroke to run 163 revolutions per minute, was put in at the Washington Mills, and has been running several years. This is a compound vertical engine, and usually indicates about 2,200 horse-power. There are also several Corliss engines running 150 revolutions. There are a few positive motion valve gears that can be run faster than the disengaging type, but there are very few persons who wish to have a quick-running large engine as there is too much anxiety about it.

Concerning piston speed, I do not consider the usual limits of much account. The trouble with high piston speed is more with the number of reversals per unit of time in obtaining it than with the speed itself. Babbitted pistons and good lubrication render the speed harmless. I expect to see engines of 5-ft. stroke making 100 revolutions per minute in the near future, as successfully running as those with 4-ft. stroke. There is, of course, no reason for high speed except for making a small engine.

Within a comparatively few years feed water heaters have frequently been placed in the exhaust pipes of condensing engines between the cylinder and condenser. This is a means of heating feed water usually some 60° F., and therefore produces a saving of coal of about 6 per cent. If with another heater the feed is heated with steam from the receiver of a compound engine a saving of coal of some 4 per cent. results, rather than to pass all of the steam through the low-pressure cylinder. Of course, if there are steam-driven auxiliaries, such as air, feed and receiver pumps the heat in their exhaust can best be extracted by means of a heater, from which an economy of some 5 or 6 per cent. will result if steam is not used from the receiver. Both of these facts, however, point to the best arrangement as being that of piping the exhaust of the auxiliaries both to the receiver and to a heater. By this arrangement no exhaust escapes to the atmosphere and if there is more than the heater can condense it passes into the receiver and thus undergoes compound use. On the other hand, if there is not as much exhaust as the heater will condense, steam from the receiver flows to the heater and maintains the temperature of the feed.

Now while these considerations show an apparent saving by having exhaust to use it is a mistake to make exhaust steam for the sake of using it, for it always results in a net waste. This comes from the condensation of the steam in passing to and from the auxiliaries and in the cylinders thereof. The use of independent steam-driven auxiliaries is so common that doubtless some engineers almost unconsciously take it for granted that they are necessary. The truth is they ought not to be used at all. I am a firm believer in attached air pumps unless the speed of the engine is too great (or for other special reason it is not advisable) and of power-driven feed pumps. In electrical plants these pumps had better be driven by motors rather than by independent steam, especially if the plant is alternating and induction motors can be used. The independent steam-driven air pump enables a vacuum to be obtained before starting, but observation shows that the attached air pump creates a vacuum sufficiently promptly.

For large engines vertical air pumps are better than horizontal because they wear better. They probably also create a better vacuum, since the valves receive the water more advantageously. In independent vertical air pumps the twin form is advantageous because it is balanced, and of course in large capacities it reduces the sizes of the air cylinders.

It is a common mistake to have air pumps too small, and vacua are often poor. When we consider what one pound less of back pressure on the low pressure piston of an engine means in extra work from the same amount of steam, the importance of a good vacuum is apparent.

In many places surface condensers offer the tempting advantage of apparently enabling the same feed water to be used over and over and thus saving its cost many times where water has to be purchased. As a matter of fact, however, when they have been installed it will almost invariably be found that the water of condensation is pumped to waste on account of boiler difficulties caused by oil. In marine practice there is no escape from the surface condenser, and as the boilers can be thoroughly cleaned at the end of each trip they manage to get along. Various means of filtering the feed water are employed, but collapsed furnaces are common, and the "Paris" came into New York once with every furnace down, thirty-two in number. The purification of condensed steam was carefully investigated by the engineers of the Manhattan Railway, New York, and jet condensers were adopted. This caused an additional expense of probably some $60,000 per year for feed water.

Notwithstanding the difficulties met so far in eliminating oil from feed water, it seems to me that it can or will be done successfully, not by separation of the oil in the steam, but by treating the water.

The use of separators on steam pipes near engines is commendable, and there are several good ones in the market. Large engines cause vibrations in steam pipes and they often tear loose from their fastenings. Therefore separators should be large and this need has brought into use the receiver separator for the purpose of having a steam reservoir to draw from and thus to diminish pipe vibration.

The use of steam jackets is not held in so high esteem as formerly, but on the high-pressure cylinder of a compound engine I cannot help thinking that they are effective in diminishing initial condensation where it occurs most plentifully. Re-heaters will ordinarily superheat steam passing into the low-pressure cylinder some 60° F. Nevertheless there are re-heaters that cause a waste of steam, and unless they are large enough they will not cause a saving sufficient to counteract the loss coming from the extra radiation from their surface. One-half square foot and upwards of re-heating surface per indicated horse-power will give good results. Re-heating by the escaping gases from boilers must be very effective but has scarcely ever been done. Dean & Main have recently designed such a re-heater for a water works pumping engine, and it will shortly be put into service.

Steam pipes present a subject for consideration. In a long line of large pipes without fittings a wrought steel or iron pipe with thin pressed steel flanges double riveted to the pipe and to each other is about as good as anything. If there are so many fittings that this is impracticable the best pipe is that with thick flanges welded on and bolted together, the next best that with the Van Stone joint, next to this that with cast steel flanges double riveted to the pipe and bolted together. A good pipe can be made by screwing pipe into cast flanges, provided the pipe goes clear through and ends flush with the face of the flange. The pipe may also be peaned out against the flange very likely with advantage, but the gasket should bear against the end of the pipe in order to make sure that the steam does not leak back around the threads. The threads should be cut on a taper and almost disappear at the end of the flange in order that the thickness should be nearly full at that point. The length of the screwed portion of the flange should be nearly or quite 4 inches.

The worst pipe is the regular commercial kind with the pipe screwed partly through the flange. They almost always leak around the threads and the length of contact between the threads and the flange is not enough to give a sufficient resisting moment to the bending that comes from expansion and contraction.

First-class lines of piping such as referred to above are often put up for safety from various standpoints, but they are interspersed with cast-iron valves and separators and perhaps other fittings. I do not recall that anybody has used cast steel separator nozzles or bodies or valves with cast-steel bodies. Yet it is not uncommon to use cast-steel boiler nozzles and tees and elbows of steel castings. In order to make a pipe system really of the best for high pressures these refinements should be introduced.

Concerning the thickness of flanges and the sizes of bolts connecting them, I think that there should be very little difference in different sizes of pipes. Flanges 2⅜-in. to 1¾-in. in thickness and 1⅛-in. bolts for most sizes I think are advisable and certainly recommend ⅞-in. bolts to be the minimum size. The proper idea, it seems to me, is to make joints so strong and rigid that they will not yield from the strains of expansion and contraction, but will compel the pipes to bend. In this way the joints will be prevented from leaking if they are properly made up. In regard to making joints, at least for what are called high pressures, the corrugated copper gasket, wholly inside of the bolts, washed with thin red lead on each side, is the best as far as my experience has gone. The flanges should be cut back a little outside of the gaskets. Pipe joints for pressures up to 205 lbs. have been made with success in accordance with these recommendations.

Stop valves should always be placed as far from boilers as possible, so as to diminish the length of dead pipe when a boiler is out of service. This prevents condensation in this amount of pipe and renders the greatest amount available for repairs when a boiler is out of service. Valves should also be in horizontal pipes so that condensation will not accumulate above them.

Feed piping should usually be of brass as hot water in wrought iron pipe will corrode through in four or five years. If the expense of this is too great cast-iron pipe can be used. Long turn fittings had better be employed, and if brass is too expensive cast-iron even on brass pipe can be used with success. Feed pipes should be of such size that the velocity of the water is from two to three feet per second. Cast-iron feed pipe if made strong enough will do in place of brass, and in many large plants would naturally be used.

Automatic check valves are good things on boilers, especially on water-tube boilers, as their tubes so often explode. They prevent the steam from other boilers blowing out at such times.

I always advocate the use of the best of machinery finished bolts for large steam pipes, as cheap bolts too often break. I also advocate spot facing the bearings for heads and nuts in order to avoid breaking off heads and threaded ends from one sided bearing and in large pipes this is rather important. For high pressures bolts should not be over 4 in. apart from center to center.

Concerning the sizes of steam pipes, they are often made too large and especially so from the boilers to the main. A velocity through pipes of 80 ft. per second for steam is slow enough, but it is often much slower.

The design of pipe hangers is difficult in order to avoid a scrap iron appearance to the system, and the commercial piper will pretty surely produce this effect if special designs are not made for him.

Pipes should always be pitched so that they will drain in the direction of the flow of steam, as an effort to drain back will not be successful, as the steam will carry the water along with it.

Expansion and contraction of steam pipes should preferably be allowed by ample bending facility of the pipes by having sufficient lengths at right angle to each other. The Pearson slip joint is, however, a good device, and for small motions the corrugated copper expansion joint is good. The latter permits lateral as well as longitudinal motion.

Copper bends should never be used because they have to be brazed; at least, I have not known any seamless drawn copper pipes to be bent. If, however, brazed pipes are well clamped or wound with wire they may be well enough.

The design of small piping is always difficult to make look well. Many steam plants have the appearance a few months or years after they are built of having many after-thought pipes, but it is certainly desirable that they should not have it when they are new. In vertical triple expansion pumping engines where the lagging is often made continuous over cylinders and re-heaters the piping is sometimes enclosed in the lagging and the spindles of the valves pass through finished thimbles, the wheels only showing. This is very neat looking.

Gate valves should always be used in water pipes, but it is not so certain that they should be used in steam pipes. The valve problem is a difficult one and it often seems as if there are no good valves, although they are probably as good as they can be.

Returning again to the matter of economy of fuel, superheated steam has returned again for consideration. It has been found that there is a great possibility here, but it will be perfectly futile to undertake its use unless the owners and engineers are determined to see that

the devices are properly worked and properly maintained. There are in Europe cases where great economy in the use of steam has been found and maintained, but no economy in fuel on account of the waste of heat in the superheating furnace. Furthermore, superheat in steam is such a vanishing condition that the greatest pains must be taken to preserve it. It is not strange that this should be so when we consider that superheated steam contains comparatively little heat even when high in temperature, and thus the head of temperature being greatly above that of the surrounding atmosphere the heat flows out rapidly. A striking case of this is known where it was desired to use highly superheated steam in a certain process. The steam left the superheater at about 800°, and when it had arrived at the point of use the superheat could hardly be identified. In this case, of course, proper means of insulating the pipe was not employed, and this serves merely to illustrate the importance of taking extraordinary precautions to cover pipes well and to use the smallest possible pipes. Such a vanishing property will naturally cause hesitation on the part of conservative persons in going to any great expense in attempting to use steam of this kind.

I am informed that at Krupp's works they have, or had, a Schmidt engine, which used as much coal with superheated steam as without. This was due to the extravagant use of fuel in highly superheating the steam. In Alsace where they use moderately superheated steam of about 150° F., they obtain a saving in coal of about 20 per cent. in slide valve simple engines and about 8 per cent. in the best 4-valve triple expansion engines.

The Norton Plain Grinding Machine.

Grinding as a finishing process for shafts, rolls, tubing and smiliar surfaces has latterly been recognized as an important advance over the more common processes of lathe finishing. Until quite recently the size and weight of the work to be handled has been thought to restrict the grinding process to comparatively small limitations. Mr. C. H. Norton, of the Norton Grinding Company, Worcester, Mass., has been a persistent investigator of the advantages of grinding and in the design of the machine which is here illustrated has given a new aspect to the process. It has been demonstrated by work done with this machine and others, similar but of lighter make, that grinding with a well-made machine is not only more accurate but is also cheaper than other methods.

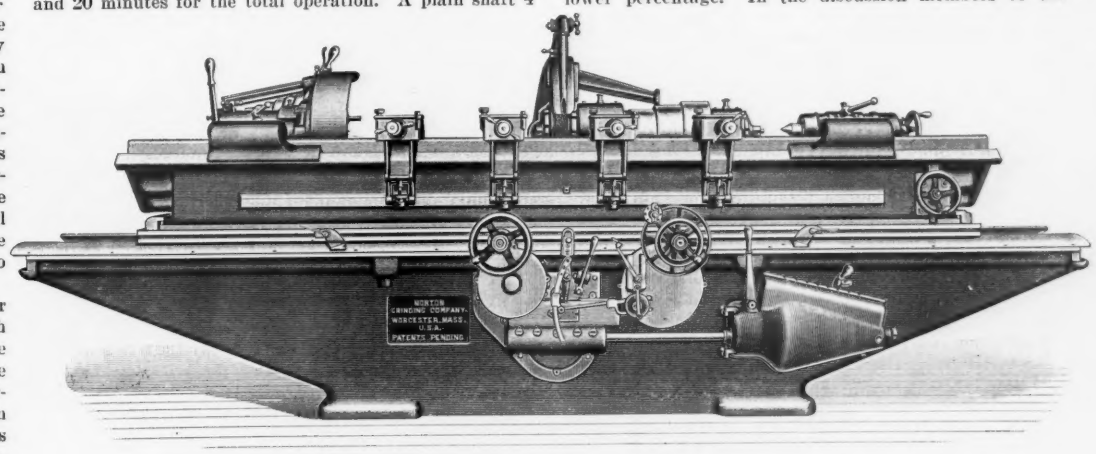
The bed of this machine is a single large casting resting on three points of support, one of these points being directly under the emery wheel support and the other two being disposed as shown in the front view of the machine. The relation of these points establishes a base outline along the lines of a triangle of practically equal sides. The weight of the machine is 9,000 lbs., the length of the base 13 ft. and the width 4 ft. 6 in. The emery wheel is 24 in. in diam. and 2 in. thick, and the machine will swing 18 in. in diam. and receive 8 ft. of length, and tapers as great as 2 in. to the foot can be ground. There are no overhead cones and all changes of speed are therefore made at the machine itself. There are 16 changes of table speed, eight changes of work speed, and six changes of wheel speed, all of which can be made without stopping the table, the work, or the wheel. The driving belt is 4 in. wide and the largest step of the spindle pulley is 10 in. in diam. From this description and the three views of the machine which are given it is apparent that very heavy and long work may be done without any considerable vibration.

We have seen a record of work done by this machine and a few typical operations are here given: Four Corliss engine valves 5 in. in diam. and 23½ in. long, turned with a lathe feed of about 12-pitch, were ground in an average of 17.25 minutes per valve, the average grinding cut being .022 in. from each valve. Four valves 7½ in. in diam. and 36 in. long, turned with a feed of about 16-pitch were ground in an average of 35.25 minutes per valve, the average grinding cut being .027 in. per valve. From one valve 12 in. diam. and 60 in. long, weighing 827 lbs., turned with a feed of 16-pitch, .025 in. was ground in 1 hour and 15 minutes. Valves of this kind have a large part of their weight on one side of the axis, and yet they are ground in this machine, without balancing, within a limit of .001 in. diam.

A pair of chilled rolls having bearings 10 in. in diam. and 8¾ in. long, the diameter of the roll portion to be ground being 17 in. and the length of roll portion 30 in., were ground complete in 12 hours, including the bearings and a form for a knife which they were intended to roll, 1-32 in. diam. being ground from one of the rolls. They weighed 1,600 lbs. each and represent the maximum weight for which this machine is suitable. A roll 10 in. in diam. and 12 in. long, which was rough from usage, was reground in five minutes; another roll in similar condition was reground in eight minutes, and a third roll in 12 minutes. One roll 10 in. in diam. and 24 in. long, much roughed by crushing emery, was reground in 1½ hours, and another similar roll in worse condition was reground in two hours.

A hardened steel roll, the body of which was 2½ in. in diam. and 3 ft. 3 in. long, and the bearings of which were 6 in. long and 1½ in. in diam., needed to be straightened. In 2½ hours the diameter was reduced .015 in. and the bearings were included in this grinding. A car axle turned with the usual roughing cut in a lathe had 3-32 in. ground from the diameter of the rough cut and the bearings were found to be perfectly true and smooth, there being no ridges or high spots. The wheel fits, bearings and collars were included in this grinding and the work was completed in an hour.

A cast-iron roll 3 ft. 8 in. long and to finish 7 in. in diam. was found to be 7-64 in. larger than desired when measured over the tops of the tool ridges. It was ground to a true roll, cutting out all tool marks in 20 minutes and leaving it then a little more than 1-16 in. too large. The 1-16 in. was ground off in two hours, making 2 hours and 20 minutes for the total operation. A plain shaft 4 in. in diam. and 3 ft. long, rough turned, 12-pitch, had .025 in. removed from it in 10 minutes. These illustrations could be multiplied almost indefinitely, but it is apparent that this machine is available for a wide range of railroad shop work and that it can be used to great economy and advantage there as well as in other branches of metal working.



The Norton Plain Grinding Machine.

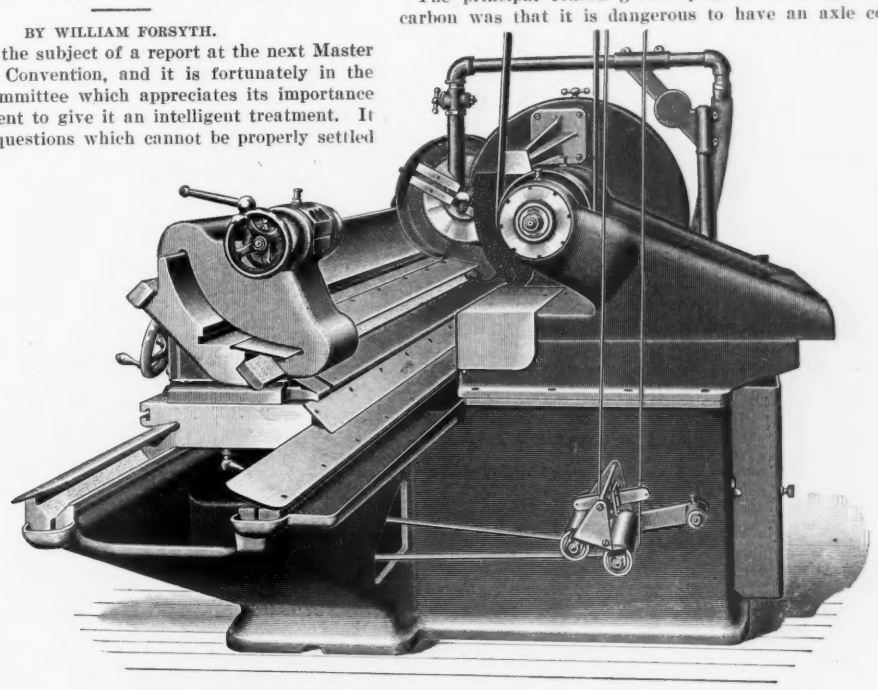
The Chemical Composition of Steel Freight Axles.

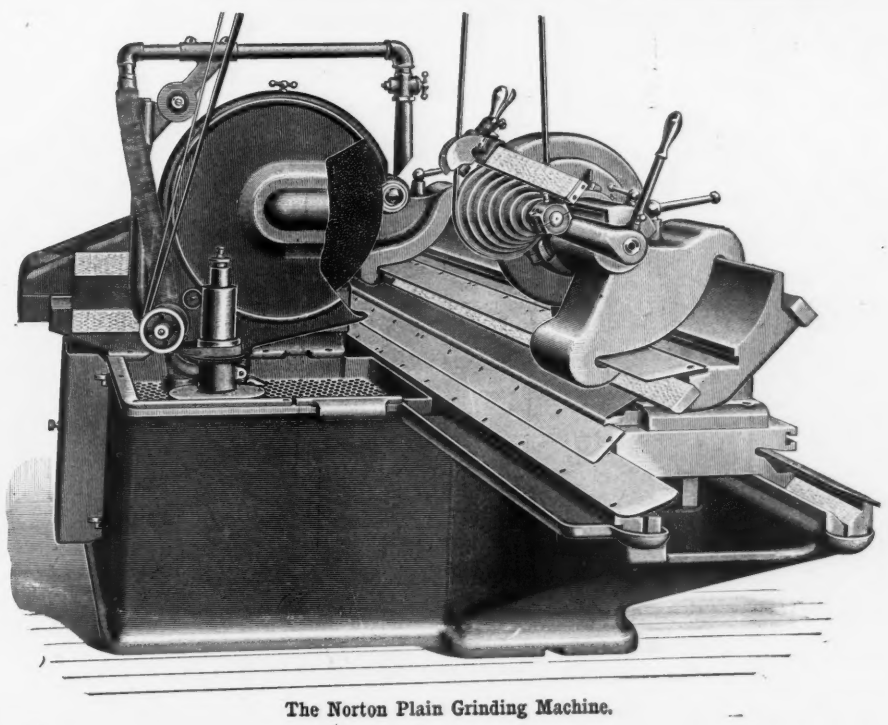
BY WILLIAM FORSYTH.

This will be the subject of a report at the next Master Car Builders' Convention, and it is fortunately in the hands of a committee which appreciates its importance and is competent to give it an intelligent treatment. It is one of the questions which cannot be properly settled by a vote of the convention when first brought before it.

The Association now has under recommended practice a specification for steel axles which was a part of the report on the 80,000-lb. axle. It appears in the proceedings for 1900, page 337, as a general specification for all steel axles, and in it the requirement for carbon is .40 with limits .35 min. and .50 max. At the last convention the Committee on Revision of Standards recommended that this requirement should be reduced to a lower percentage. In the discussion members of the original committee on 80,000-lb axles objected to this change and favored a reference to a new committee to report at the next convention. The subject as referred to the new committee relates not only to the carbon contents, but to the chemical composition of steel axles in general. It was pointed out in the discussion that in the best practice the tendency was to use higher carbon than was formerly specified, especially for larger sections.

The principal reason given by those favoring lower carbon was that it is dangerous to have an axle con-





The Norton Plain Grinding Machine.

taining .50 carbon heated to dull red and then quenched by cold water. No facts have yet been presented to show that any more high carbon axles have been broken in this way than those containing low carbon. The experience of a large road which has used thousands of axles made to the present M. C. B. requirements during the past five years has been that few, if any, have broken in this way; but the most frequent cause of axle failure is that due to stresses exceeding the elastic limit of the material in the outer fibres resulting in continuous bending, then cracks in detail, and finally complete fracture. The tendency, therefore, should be to increase the elastic limit of axle steel and the specification for it should require a percentage of carbon which will secure high elastic limit with proper tensile strength and elongation.

The specification proposed by the International Association for testing materials does not have any requirements as to the carbon limits, nor for tensile tests. It depends upon the deflection under the drop tests to indicate the "stiffness" of the structure under which term are included those qualities which would be revealed and measured by both chemical and tensile tests. The wisdom of making the drop test a substitute for laboratory and test-room investigation depends upon how accurately drop tests can be made to interpret desired qualities and how carefully the height and deflection requirements are standardized with reference to tensile strength, elastic limit and the carbon contents.

There is a strange inconsistency in the present M. C. B. specification for drop tests in that it allows a deflection within limits, having a difference of 1-in. for the 60,000-lb. axle, 2-in. for the 80,000-lb. and only ⅝-in. for the 100,000-lb. axle. The deflections proposed by the International Association simply state a maximum as a result of the first blow and these are not comparable with the M. C. B. requirements because the height of the drop for the different axles does not correspond. The limiting deflections in the M. C. B. specifications are given to within 1-16 inch, and this is a refinement which is hardly necessary and should be changed in the new specifications. The height of drop proposed by the International Association for the standard "B" axle is 9½ ft. greater; for the "C" axle 14 ft. greater, and for the "D" axle 7 ft. greater than the M. C. B. practice, and the maximum deflections in the two specifications are very nearly alike.

If an axle steel containing .35 to .50 per cent. carbon will deflect an amount corresponding to these maximum requirements under a drop from the lower height prescribed by the M. C. B. specification, what must be the grade of steel in an axle which shall not exceed these deflections under a drop of the same weight from a point 14 ft. higher? It is evident that the elastic limit must be higher and consequently the carbon contents higher in a carbon steel.

We have endeavored to show that the steel manufacturers favor an axle steel which is higher in carbon than the present M. C. B. limits, and it is not likely that the M. C. B. committee on the subject will favor any reduction in the carbon contents from present practice. It is safe to say that the great bulk of railroad axles will hereafter be made by one steel company and it is becoming more and more necessary for the railroads and the steel companies to agree on a common specification for axles which shall be satisfactory to both parties.

Specified Drop Tests for Axles.

Axle.		Diameter at Center.	M. C. B. Height of Drop.	M. C. B. Deflection.	I. A. T. M. Height of Drop.	I. A. T. M. Deflection.
B..	60,000	4⅝ in.	21½ ft.	7⅛ in.–8⅛ in.	31 ft.	8 in.
C..	80.000	5⅜ in.	29 ft.	6⅞ in.–8 1/16 in.	43 ft.	7 in.
D..	100,000	5⅞ in.	36 ft.	5 1/16 in.–6 1/16 in.	43 ft.	5½ in.

The table shows the specification for drop test of axles as recommended by the M. C. B. Association, and that by the International Association for testing materials.

Comparative Efficiencies of Freight Cars With Some Observations Concerning Their Design.

BY GEORGE I. KING AND ALBERT PANCOAST.

It is pertinent to inquire upon what basis comparisons between efficiencies of freight cars should be made. In any machine, its efficiency is the ratio of the useful work got out of it to the total work done upon it or put into it. A somewhat similar conception applied to railroad freight cars involves the ratio of the useful or paying load to the total tonnage hauled; the latter of course comprising the dead weight of the car and its maximum, or perhaps its average, paying load. This is the usually accepted method, varied in its form of expression to suit individual preferences. For example, a car weighing 38,000 lbs. and having a maximum actual capacity to haul 110,000 lbs., might be considered to have a ratio; first, of dead weight to paying freight of $\frac{38,000}{110,000}$ or $\frac{34.55}{100}$; that is to say, 34.6 per cent. approximately; second, we might say the ratio of dead weight to *total haul* is $\frac{38,000}{38,000+110,000}$ or $\frac{38,000}{148,000} = \frac{25.7}{100}$ or 25.7 per cent. In other words, of the total load behind the locomotive in this case, about one-fourth is made up cars and the remaining three-quarters is revenue freight.

Perhaps in many respects the above discussion is quite elementary, but it is nevertheless desirable to keep these points clearly in mind as an aid to a thorough grasp of the question under discussion. The foregoing leads to a consideration of the fact that, to use this method of comparison with intelligent understanding, it is essential that the terms or elements entering into the calculations be not hypothetical or mere assumptions; meaning by this, that we be reasonably sure of our facts before applying the formulae.

Of course the only facts involved are questions of weight and capacity; on the one hand, the light weight of the car, and on the other, its actual ability to haul tonnage, which implies (a) strength) and (b) available space. As to the weight of the car in the case of equipment already built, a reliable track scales used possibly once a year, will insure all needed information, but for the real capacity, accurate data covering every load carried is essential, and, provided exceptional cases tending to depart from average results are barred, nothing further will be necessary. In the case of *proposed new equipment*, however, only one term of our efficiency equation is readily obtainable, namely, the light weight of the car. This, of course, must be arrived at from carefully made estimates, but that it is possible to calculate the weight of a steel freight car or of a composite structure with an accuracy of 1 per cent. or better, has been frequently demonstrated. To be sure, the actual average service loads in a case of this sort could be had only after the equipment was in use long enough to yield such information, but since for new cars not yet constructed this is impossible, some different scheme must be provided.

This suggests the thought that a large proportion of

COMPARATIVE DATA RELATING TO DIFFERENT TYPES OF STEEL HOPPER CARS.

		1. Type.	2. Builder.	3. Owner or Lessee.	4. Load Limit, Lbs.	5. Light Wgt., Lbs.	6. Length Inside. Ft.—In.	7. Width Inside. Ft.—In.	8. Height Rail to Top of Side. Ft.—In.	9. Journals. In. × In.	10. Cubic Contents, Level Full. Cu. Ft.	11. Cu. C'ntn's to Top 30° Heap. Cu. Ft.	12. Ratio Dead Weight to Total Haul.	13. Ratio Load Limit to Total Haul.	14. Dead Weight per Cu. Ft. of Heaped Contents
50-Ton Cars.	Coal, Ore, etc.	Structural steel	A. C. & F. Co.	L. S. & M. S.	110,000	38,300	32— 0	9— 0	11— 7⅝	5½ × 10	1,800	2,140	25 9	74.1	17.9
		Pressed steel	Pressed Steel Car Co.	Erie R. R.	110,000	36,300	30— 0¼	9— 6	10— 0	5½ × 10	1,680	2,030	24.8	75.2	17 9
		Pressed steel	Pressed Steel Car Co.	L. V. R. R.	110 000	37,600	30— 0¼	9— 6	10— 2½	5½ × 10	1,738	2,088	25.5	74.5	18.0
		Pressed steel	Pressed Steel Car Co.	L. S. & M. S.	110,000	36 600	30— 0¼	9— 6	10— 0	5½ × 10	1,680	2,030	25.0	75.0	18.0
		Pressed steel	Pressed Steel Car Co.	P. R. R.	110,000	39,600	31— 6½	9— 6	10— 0	5½ × 10	1,685	2,056	26.5	73.5	19.3
		Pressed steel	Pressed Steel Car Co.	B. & O R. R.	110,000	36,700	30— 0¼	8— 8½	10— 7½	5½ × 10	1,590	1,886	25.0	75.0	19.5
	Ore.	Structural steel	A. C. & F. Co.	Lebanon Furnaces	110,000	31,500	25— 0	9— 0	10— 0	5½ × 10	1,028	1,292	22.3	77.7	24.3
		Pressed steel	Pressed Steel Car Co.	Lorrain Steel Co.	110,000	29,500	20— 3¾	7— 6	9— 0	5½ × 10	600	744	21.2	78.8	38.7
40-Ton Cars.		Pressed steel	Pressed Steel Car Co.	B. & O. R. R.	88,000	34,800	30— 0¼	8— 8½	10— 2½	5 × 9	1,590	1,886	28 3	71.7	18.5
		Structural steel	A. C. & F. Co.	No. Pac. R. R.	88,000	34,600	30— 0	9— 0	10— 5⅝	5 × 9	1,445	1,763	28.2	71.8	19.6
		Structural steel	A. C. & F. Co.	C. R. R. of N. J.	88,000	33,900	30— 0	9— 0	10— 5⅝	5 × 9	1,400	1,718	27 8	72.2	19.7
		Pressed steel	Pressed Steel Car Co.	P. & L. E.	88,000	31,750	29— 0¼	8—10¼	9— 1	5 × 9	1,267	1,551	26.6	73.4	20.4

COMPARATIVE DATA RELATING TO DIFFERENT TYPES OF STEEL GONDOLA CARS.

	1. Type.	2. Builder.	3. Owner or Lessee.	4. Load Limit, Lbs.	5. Light Wgt., Lbs.	6. Length Inside. Ft.—In.	7. Width Inside. Ft.—In.	8. Hgt. Floor to Top of Sides. Ft.—In.	9. Journals. In. × In.	10. Cubic Contents, Level Full. Cu. Ft.	11. Cu. C'ntn's to Top 30° Heap. Cu. Ft.	12. Ratio Dead Weight to Total Haul.	13. Ratio Load Limit to Total Haul.	14. Dead Weig t per Cu. Ft. of Heaped Contents
50-Ton Cars.	Pressed steel	Pressed Steel Car Co.	C., L. S. & E.	110,000	31,000	41— 9	9— 4⅞	3— 6	5½ × 10	1,374	1,867	22.0	78.0	16.6
	Pressed steel	Pressed Steel Car Co.	C. & A.	110,000	35,600	41— 9	9— 4⅞	4— 0	5½ × 10	1,572	2,064	24.2	75.8	17.2
	Structural steel	A. C. & F. Co.	C. & E. I.	110,000	36,500	40— 0	9— 6	4— 0¾	5½ × 10	1,565	2,125	24.9	75.1	17.2
	Structural steel	A. C. & F. Co.	E., J. & E.	110,000	37,000	40— 0	9— 0¾	4— 0	5½ × 10	1,490	1,927	25.2	74.8	19.2
	Pressed steel	Pressed Steel Car Co.	P., B. & L. E.	110,000	31,200	32— 0	9— 2	3— 6	5½ × 10	1,042	1,393	22.0	78.0	22.4
40-Ton Cars.	Pressed steel	Pressed Steel Car Co.	U. Pac.	88.000	31,500	34— 6	9— 4½	4— 0	5 × 9	1,308	1,706	26.4	73.6	18.5
	Structural steel	A. C. & F. Co.	C. & A.	88,000	32,450	38— 0	9— 3	3— 6 1/16	5 × 9	1,270	1,700	26.9	73.1	19.1
	Pressed steel	Pressed Steel Car Co.	B. & O.	88,000	31,700	34— 0	9— 2	3— 10	5 × 9	1,210	1,585	26.5	73.5	20.0

COMPARATIVE DATA RELATING TO DIFFERENT TYPES OF BOX CARS.

	1. Type.	2. Builder.	3. Owner or Lessee.	4. Load Limit, Lbs.	5. Light Wgt., Lbs.	6. Length Inside. Ft.—In.	7. Width Inside. Ft.—In.	8. Hgt. Floor to Top of Plate. Ft.—In.	9. Journals. In. × In.	11. Cubic Contents to Top of Plate.	12. Ratio Dead We'ght to Total Haul.	13. Ratio Load Limit to Total Haul.	14. Dead We'ght per Cu. Ft. of Contents.	
30-Ton Cars.	Pressed steel under frame	Pressed Steel Car Co.	Erie R. R.	66,000	44,500	50— 2¼	8— 9¼	9— 6	4¼ × 8	4,182	40.3	59.7	10.6	Vehicle car.
	Wood	A. C. & F. Co	C. G. W.	66.000	32,200	36— 0	8— 6	8— 0	4¼ × 8	2,448	32.8	67.2	13.1	
	Wood	A. C. & F. Co.	N. Y. C. & St. L.	66,000	32,300	34— 0¼	8— 2¼	7—10½	4¼ × 8	2,194	32 9	67.1	14.7	
	Wood	A. C. & F. Co.	M. C. R. R.	66,0 0	33,900	34— 3¾	8— 2⅜	8— 1	4¼ × 8	2,273	34.0	66 0	14.9	
	Pressed steel under frame	A. C. & F. Co	P. & R.	66.000	32,780	30— 0¼	8— 6¼	8— 6¼	4¼ × 8	2,180	33.2	66.8	15.0	
	Wood	A. C. & F. Co.	N. Y. C. & H. R.	66,000	32,300	34— 4	8— 3	7— 3½	4¼ × 8	2,052	32 9	67.1	15.7	
40 Ton Cars.	Pressed steel under frame	Pressed Steel Car Co.	Union Pac.	88,000	40,300	40— 0	9— 0	9— 3	5 × 9	3,330	31.4	68.6	12.1	Comb. box and furnit. car
	Structural steel under frame	A. C. & F. Co.	Northern Pac.	88,000	39,750	40— 0	8— 6	7— 6	5 × 9	2,550	31.1	68.9	15 6	
	Wood	A. C. & F. Co.	Lehigh Valley	88,000	36,000	34— 0	8— 0	7— 6	5 × 9	2,040	29.0	71.0	17.6	
	Wood	A. C. & F. Co.	P. R. R.	88,000	35,800	33— 9¼	8— 0	7— 4½	5 × 9	1,992	29.0	71 0	18.0	

the revenue producing freight of the country is bulky stuff, such as grain, lumber, ores, coal, manufactures, etc., which require a fixed amount of space in the transportation elements used to handle a given tonnage of these materials. This fact, axiomatic as it is, does not sometimes receive the attention it merits when equipment of different designs but of the same general style is being compared. For illustration, loose statements are frequently made that, Tom's "40-ton gondola" only weighs, say "31,000 lbs.," while Dick's trails along with "33,000 lbs." and Harry's is almost out of the race at "35,000 lbs." Many people do not stop to inquire whether all these cars have the same strength and cubical volume, and could accommodate the same tonnage of all kinds of freight, or whether the reverse condition is true. It even seems to be enough for some persons (who know better) to assume that a so-called 30, 40 or 50-ton car, as the case may be, should weigh "about so much," without any regard to whether it is a 40-ft. gondola with 4-ft. sides, or, if it is but a 34-ft. car with 2½-ft. sides. To more forcibly bring out the absurdity of this, attention is called to Figs. 1 and 2 herewith. Fig. 1 represents a 50-ton car weighing 38,300 lbs. loaded with 110,000 lbs. of 52-lb. coal. Fig. 2 shows a so-called "50-ton" car, one of a large number in use, weighing about

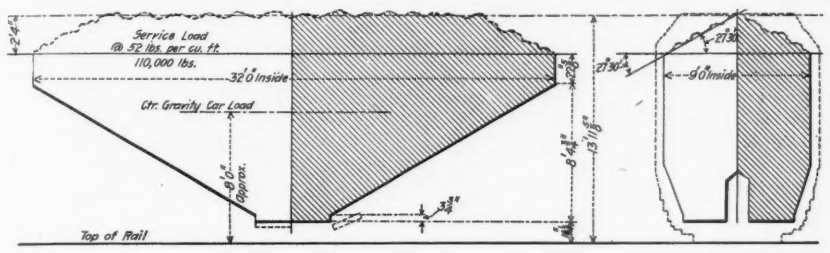


Fig. 1.

Approximate cubic contents to top of sides	1,800 *cu. ft.*
" " " " " " 30 *deg. heap*	2,140 " "
Marked capacity	110,000 *lbs.*
Light weight	38 300 "
Dead weight per cu. ft. carrying capacity to top of sides	21.3 "
" " " " " " " " " " 30 *deg. heap*	17.9 "
Ratio of dead weight to paying freight @ 52 lbs. per cu. ft. top of 30 deg. heap	34.4%

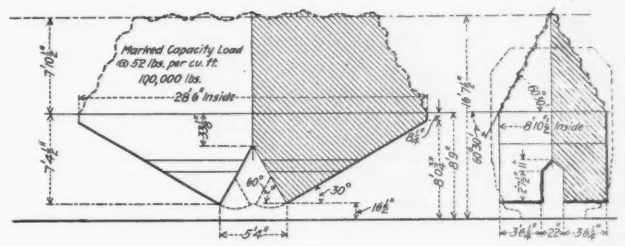


Fig. 2.

Approximate cubic contents to top of sides	1,628 *cu. ft.*
" " " " " " *heap*	1,923 " "
Marked capacity	100,000 *lbs.*
Light weight	37,150 "
Dead weight per cu. ft. carrying capacity to top of sides	36.1 "
Ratio of dead weight to paying freight @ 52 lbs. per cu. ft. 30 deg. heap	54.2%

37,150 lbs. and loaded with 100,000 lbs. of 52-lb. coal. The car shown in Fig. 2 is equipped with 5 x 9-in. nickel steel axles and was designed to carry 50 tons; its marked capacity is 100,000 lbs. Both of these cars would readily handle 50 tons of iron ore with ease, at least so far as cubic capacity is concerned, but while the first would also haul 110,000 lbs. of average coal, it is manifestly absurd to consider the second on the same basis, at all events for coal freight.

When, therefore, exact or approximate efficiencies are to be compared of cars intended to carry materials of different kinds, and the great bulk of equipment comes under this heading, why not consider the *maximum cubic contents in connection with the light weight* as a fair and impartial field for investigation? In other words, make comparisons of light weight per foot of maximum cubic capacity rather than on the basis of dead weight alone? This presupposes, of course, that the relative strengths of the cars in question are identical; this matter will be referred to more fully in a later paragraph. For box car types, the cubic capacity could be figured on the clear length and width inside, and height measured from floor to top of plate; for hopper or high side gondola cars, intended to handle coal, ores, lumber, etc., estimate the cubic contents to the top of perhaps a 30 deg. heap; for flat and low-side gondola cars, the comparison could be made on the basis of body weight per foot of length over end sills, this of course to be applied with reasonable discretion.

To more clearly bring out the reasons for the above method of comparison and also to demonstrate that some of the differences popularly supposed to exist between the efficiencies of certain types of cars are mere myths, the subjoined tables have been compiled from various sources, and are here submitted as interesting examples of modern practice. The calculations involved have been independently checked and it is confidently believed the results are reliable within an accuracy of about 1 per cent. Further than to call particular attention to columns 13 and 14, comment on our part is superfluous. The latter indicates the dead weight per cubic foot of heaped volume for hopper and gondola cars and a similar weight per cubic foot to top of plate for box car types. Column 13 gives *supposed* ratios of revenue freight to total haul, the calculation being based upon marked load limits and actual light weights. Observe that some designs rating high in this regard do not make so good a showing when examined with respect to their dead weight per foot of cubic contents; the reason is, of course, not far to seek.

In the above discussion, repeated reference has been made to an assumed equality of strength between the different cars to be compared; we here desire to present a few observations on car design in general, and particularly to enter a plea for a more thorough realization on the part of railroad men and car builders, that modern freight equipment and especially steel cars, should be designed throughout and actually built in accordance with the known laws and facts of structural and mechanical engineering and not on the haphazard and cut-and-try method, which, unfortunately, has been but too often adopted.

Up to the present time, and particularly during the last fifty years, there has been accumulated a vast store of valuable information concerning the strength of materials, the laws governing the action and reaction of forces, the deterioration of structures under repeated application of loads, and much more of a similar nature. Compilations from this immense mass of actual practice, laboratory tests and all kinds of scientific research and investigation, are to-day available. Why, therefore, in the design of structures so vital to the welfare of the country as freight cars, involving as they do the expenditure of millions in money and fraught as they are with danger to life and property in the event of failure, should not every advantage be taken of this accumulated knowledge of engineering experience which is so close at hand and yet so seldom used? Of course, it is not meant to imply by this that nothing has been done in the direction of scientific car design; on the contrary, something more than an auspicious beginning has been already made. Witness the elaborate and painstaking investigations of the M. C. B. Axle Committee, with the result that there are to-day in use thousands of standard axles that have really been designed and not merely dimensioned. Other details have likewise been standardized with satisfactory results, but the general principles that should underlie the proper design of freight car structures seem to be as hazy and nebulous as ever.

It is an established rule in bridge engineering, that certain maximum loads are to be assumed which shall in no case develop fiber stresses exceeding quantities rigidly fixed for both tension and compression and adapted to the nature of the materials to be employed and the form in which these are shaped. Yet there are running to-day, thousands of freight cars in both steel and wood (and these are nothing but bridges on wheels) in which the allowable stresses of good structural practice are greatly exceeded, showing that little or no attention has been given this important matter, either from an ignorance of the underlying principles of true engineering or as a result of commercial greed, causing sacrifice of strength in order to cut down the amount of material that should properly be employed, and so cheapen the construction. Perhaps this condition is due more to the former reason than to the latter, for numerous instances could be pointed out where the strength of a riveted connection, as shown by a simple calculation, is only one-quarter or one-half that of the member or members of which it is a part, which is, of course, entirely inconsistent with any reasonable conception of economy. Furthermore, it is well known that a simple beam, a column, a plate girder or a truss of certain fixed size and design, will support with safety a definite load and no more. Yet many instances are at hand where this fact was evidently lost sight of or was perhaps not even known in car building and as a consequence of resultant failures, many mechanical men now believe (we think mistakenly) that unless modern freight equipment is designed along the lines developed by past experience with wooden construction the cars are necessarily lacking in the essentials of strength and durability. Certainly, in view of the advanced state of structural engineering as it exists to-day, any such view is very unwise, to say the least, and it is to be hoped that these ideas will soon be forced aside and that true engineering knowledge will be allowed the recognition in this field that it deserves.

Altoona Notes.

It goes without saying that there is always something interesting at Altoona. The shops themselves and the methods of work have been undergoing improvement for many years and this is still true. About two years ago a systematized plan was started to put the Altoona shops in a better position than ever for economical and quick repair work. In the course of these improvements a great deal of tearing down and rebuilding has been done. Walls have been strengthened for traveling cranes of high capacity; some buildings have been removed entirely and new ones have been erected.

Among the recent changes is in the spring plant, which was fully described in the *Railroad Gazette* of January 25, 1901. The building occupied by this department has been torn down and the machinery installed in new quarters. A new shop has been erected for wheel work and traveling cranes have been supplied wherever they can be used to advantage.

This statement applies first to the erecting shops, where the walls have been taken to carry the cranes that are used to lift the locomotives bodily from one track to another. They are also installed in the machine shop and even in the older buildings where the ceiling is very low. In the new wheel shop there is a fine crane of 12½ tons capacity, but the most radical departure is to be found in the substitution of the traveling crane for the transfer table. Such a crane is now erecting, and when it is in place engines entering or leaving the shops will be lifted and carried to any point along the face of the repair shops, just as they are now carried by the transfer table. In all, nine new traveling cranes have been or are being installed.

The growth of the locomotive in recent years is shown by the changes that are made in roundhouse facilities. The length of the engine with its tender has been so increased that it is impossible to shelter them within the walls of a roundhouse that was originally thought to be very large. Doors have been removed and an overhanging roof built out along the inside face of the building. This affords some protection against storms, but makes it impossible to close the house. As for turntables, two of the old ones have been removed and new ones having a length of 75 ft. put in their place. These tables make it possible to turn any engine that is now on the road and will probably be able to handle any that will be built for some time to come.

In addition to the shop improvements the usual amount of original investigation is being carried on. To determine the economical value of the steel-tired wheel in freight service an order has been placed for a large number of these wheels of various styles. They will be put under cars of 100,000 lbs. capacity and allowed to work out their own salvation in direct competition with cast-iron wheels in the same service. This order led to a newspaper statement that the Pennsylvania Railroad had adopted the steel-tired wheel for heavy freight cars. There is no foundation for such a rumor; it is merely one of many lines of investigation.

In the laboratory the amount of work done is constantly increasing. The chemical laboratory that was started with Dr. Dudley as the sole occupant in charge has grown beyond the limits of the most sanguine expectations of its promoters. New fields of usefulness are being constantly discovered and among the latest is that of the bacteriologist. A department for this branch of work has recently been installed. His work is along the lines of improving the sanitary conditions of the cars, shops and offices, with particular attention to obtaining suitable water for passenger cars. Ordinarily it is considered quite sufficient that the water should be cold, and the source of supply is the last thing about which the transportation company bothers itself. It is, therefore, a new departure to find such an investigation occupying a prominent part in everyday work.

The Pennsylvania specifications are so frequently used by other purchasers that it is interesting to note that a set is now in course of preparation for plush. It is the intention to make a thorough investigation into the subject and ascertain just what quality, strength, material and method of manufacture will produce an article best suited for use on the seats of passenger cars.

Among other subjects of investigation the storage battery is now attracting some attention in connection with the possibilities of using it for railroad work. Acetylene gas is also under review and experiments are being made with it combined with shale gas, the latter being enriched with about 25 per cent. of acetylene.

While upon the subject of the chemical laboratory at Altoona it may be well to call attention to the success following the use of the specifications for steel axles that emanated from that department. Before the introduction of the present specifications a great deal of trouble was experienced with broken axles. It was undesirable that the size should be increased and it was suggested that the difficulty might be obviated by the use of a stiffer material. This led to further investigation that resulted in the adoption of the present specifications. Since these have been put into force the breakage of steel axles under cars has entirely disappeared. Only three axles have given way out of some thousands

(*Continued on page 416.*)

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EDITORIAL ANNOUNCEMENTS.

CONTRIBUTIONS—Subscribers and others will materially assist us in making our news accurate and complete if they will send us early information of events which take place under their observation, such as changes in railroad officers, organizations and changes of companies in their management, particulars as to the business of the letting, progress and completion of contracts for new works or important improvements of old ones, experiments in the construction of roads and machinery and railroads, and suggestions as to its improvement. Discussion of subjects pertaining to ALL DEPARTMENTS *of railroad business by men practically acquainted with them are especially desired. Officers will oblige us by forwarding early copies of notices of meetings, elections, appointments, and especially annual reports, some notice of all of which will be published.*

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One of the subjects that will come before the Master Car Builders' Association at the convention this year is that of re-weighing freight cars. We need not say that wooden freight cars lose weight for some time after they are built, losing often as much as 2,500 lbs. in their first year. In the interest of carriers (and of sellers, too, when they sell by railroad weight) the cars should be re-weighed and stenciled several times in the first years of their lives. Just how often they should be re-weighed and when weighing may properly cease are questions which recur from time to time and do not appear to get themselves settled. Obviously, they should always be re-weighed after passing through the shops for extensive repairs, but the American Railway Association has recently decided that it is not necessary to re-weigh freight cars after their third year. It happens, in fact, that old cars sometimes increase in weight. This might take place during a prolonged wet season, and it is said that it sometimes occurs from accumulation of particles of stone, coal, ore dust, etc. It hardly seems likely that the increase in weight could be important except by extensive repairs, but the decrease, of course, is important; indeed, large furniture cars are said to lose as much as a ton in the first six months. Tank cars and refrigerator cars belong in special classes, and it is questionable if it is worth while to re-weigh these. Of course, they must carry the light weight for purposes of tonnage rating, but the commodities transported in tank cars are not generally rated by weight and the weight of the car is not of importance to the shipper; but if the light weight is stenciled on the car it will help the transportation department in making up engine loads. With refrigerator cars the case is still different. These are constantly subject to conditions which materially affect the weight owing to the many different methods of icing and ventilating. Frequently shippers of beer simply pile ice on the top of the kegs or barrels and the floors and underframes of refrigerator cars are more or less soaked with water. But obviously even these cars should bear the light weight mark for purposes of rating if for no other reason, and it may well be that they should be re-weighed at least as often as an ordinary box car.

Several members of Parliament and officers of the State in England, as well as a good many newspapers on both sides of the water, have been talking the last week or ten days about the comparative merits and demerits of American and British locomotives. An officer of the Midland is reported to have said that American engines sent to that road recently have burned from 20 to 25 per cent. more fuel, used 50 per cent. more oil and cost 60 per cent. more in repairs than the British built engines. We can form no opinion of the correctness of such a statement or of its value without particulars. We should not be at all surprised to know that the American locomotives in the first six months of their performance had cost more for repairs than British locomotives in their first six months, but even 60 per cent. more need not be much money. We have had considerable opportunity to talk with English inspectors who have been watching the building of locomotives in this country, and we think without exception their testimony has been that our boiler work is below the British standard. It is a matter of common knowledge that American locomotives sent abroad have had to be taken at once into the shop to have leaky seams doctored. This experience has not been peculiar to any one of our builders or to locomotives sent to any one country. We do not consider it "patriotic" or "American" to deny with indignation this fairly well-established fact. It is a good deal more patriotic, as well as business-like, to see that it does not happen again. The difference in oil consumption is a very small matter; at most the saving would not be more than one-half of 1 per cent. of the locomotive costs. In fuel consumption the difference mentioned in the cable reports may or may not exist. Every motive power man and operating officer will understand how, in special cases, there might be this or even a greater difference in fuel consumption. It is notorious that our engines are worked harder and expected to work harder per unit of weight and per unit of grate area than the British engines. It is a part of our whole economic scheme of driving our machinery harder. Obviously, this more intense work means burning coal with less economy, but our people point to the net result, namely, the less ultimate cost per ton per mile. It is our habit to consider a locomotive as a part of the machinery which manufactures transportation and not as a device contrived for laboratory demonstrations in fuel consumption.

Cast Steel Locomotive Frames.

On page 10 of our volume of 1899 we gave the status of the cast steel locomotive frame as far as information was then available. The matter there published included some chemical analyses and records of physical tests of the material used in locomotive frames by one of the most important steel making establishments in the United States. This steel plant, as it happens, led the advance in making cast steel locomotive frames, and did much of the experimental work which was necessary on the earlier orders. Since that time no one has cared to speak very positively of the final result of using cast steel frames, these being justly regarded as to a certain extent experimental. We have, therefore, awaited the time when those having definite knowledge of the subject should be ready to make it public, meanwhile holding the belief that the cast steel frame must become a permanent feature in locomotive building.

Our views, as expressed in 1899, were thought by some to be in advance of the art of steel making. It was said by a correspondent whose conservatism is to be respected that the difficulties from blow holes and shrinkage flaws might offer greater obstacles to advancement than those implied in our summary of the situation, and that he expected a more gradual introduction of cast steel frames than was anticipated in our article. Since those expressions were published there have been many cast steel frames used on heavy locomotives. It has been shown in practice that the views of our correspondent were not wholly unfounded in the matter of imperfections in castings, and yet the many steel frames now in use and their service record as a whole, seem to justify our forecast for their early general adoption.

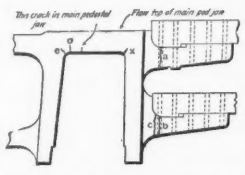
In this issue we give what seems to be the most complete and explicit statement of the several features of the steel frame question that it has thus far been possible to make. Mr. R. M. Galbraith's article, which appears on another page, gives a complete design of his patenting, and contains a record of wear of driving boxes in regular heavy service, with the mileage of the nine locomotives considered. The driving boxes of these locomotives are cast steel, with all faces babbitted. There are also in that article records of defects found in cast steel frames having rails of general rectangular cross section, similar to the old wrought iron frame sections. These defects as there enumerated serve to point Mr. Galbraith's argument for making a frame of I-beam section such as his own, or of other relatively light cross section, the advantage being not confined to lightness for a given strength, but being also in offering less chance for concealed blow holes, or for imbedded dross, as for example, in the one extreme case which he quotes, where large pieces of foreign matter were found in a broken frame.

The points of Mr. Galbraith's argument are well taken in certain respects, and as against the criticism that destructive shrinkage strains might exist in a frame such as made from his design, he has the record of 11 engines for the term of years given, without a frame failure; while on 10 locomotives having forged frames there were six broken frames due to imperfect welding during the same period in which the record of engines having cast steel frames stands clear. The statement that a cast steel frame of the design shown can be made at less cost than a wrought iron frame of the same capacity is an important one, and should receive serious consideration. It is but just to say that within our own observation has come a broken wrought iron frame wherein the failure was caused by a defective weld in the top rail back of the No. 3 pedestal jaw of a 10-wheel engine, the external surface of the frame being perfect before the break occurred and revealing, when broken, an unwelded area in which a circle of three inches could have been inscribed, in the heart of the frame. This is a most glaring example of concealed flaws in welded frames, and would seem to fully offset the grossest defect from dross in cast steel frames mentioned by Mr. Galbraith. This and other information here given is definite and to the point, and it should do one of two things, namely: Go far toward the advancement of the steel frame in locomotive building; or bring out definite statements of inherent difficulties, if there be such, as seen by those who believe there is reasonable objection to steel frames, but have not spoken for general information.

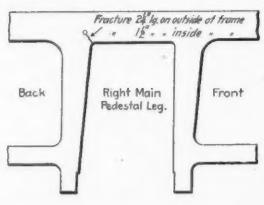
The testimony in the article referred to does not stand alone. We have now before us records from 12 important railroad companies and one steel works who have a large number of locomotives with cast steel frames. The records of 219 locomotives are there given, covering practically the entire range of work required of locomotives in the United States, both freight and passenger. The great mass of the evidence in these letters is in favor of the cast steel frame, one of the commonest expressions being in sense as follows: "We have had no trouble with any of the steel frames, and they appear to be as satisfactory as wrought iron frames." There are within our knowledge many other locomotives than those covered by these letters, with steel frames, the percentage of defects among which falls so low as compared with failures in wrought iron frames that their record is very encouraging.

There are failures of wrought iron frames, and likewise there have been failures of cast steel frames, and from the records of one railroad where they were most frequent on one class of engine having steel frames the accompanying sketch is given.

There were several repetitions of the failures at *a* and *b*, one failure at *c*, three at *o*, two at *e* and one at *x*. Other defects are indicated by arrows; for example, a crack and a blow hole in the top rail over the pedestal. The railroad having this experience naturally reports that these frames were not as satisfactory as wrought iron frames, but the frequency of breaks in the same section of frame would seem to indicate that there was defective design. That report states, however, that a considerable amount of metal having blow holes was found in the frames.



Another small sketch here given shows a single crack recorded against one of a number of heavy locomotives on another railroad. The fracture is shown at the back fillet of the right main pedestal, and the hole shown was drilled to stop the progress of the crack. The fracture was not traceable to any flaw in the metal, and the inference is that there was an undue strain there, because of some unfavorable circumstance in the process of casting. No duplicates of this failure had occurred in the frames of this class of engine at the time the record was sent us, and we therefore classify it as an isolated case.



Reviewing these records the fair conclusion would seem to be that cast steel for locomotive frames has latterly made great strides toward permanent use, but so quietly that few of us have realized to what extent and how successfully it has been done.

Freight Car Couplers.

While essentially all freight cars used in interstate service have been equipped with M. C. B. couplers for nearly a year, yet there has apparently been no real decrease in the volume of business of the coupler companies although this business now consists only of couplers for new cars and for renewals. The number of new freight cars built last year was practically the same as the year before, and in the earlier year many couplers were being applied to old equipment; hence it may be inferred that renewals of couplers is already a big item. This inference is further verified by railroads, and we have heard substantial motive power officers say recently that the conditions are such that the bulk of the couplers now in use will be out of service in a few years, giving place to stronger couplers. That is probably not far from true. There have been endless discussions about increasing the strength of the coupler and improving it in other ways, but we are most concerned now not with the general question, but with the actual efforts to bring about these changes and with the directions which improvement is really taking.

As to couplers of greater strength one of the most significant things is the provision that some of the largest makers of malleable iron couplers are making to furnish cast steel couplers as well. This perhaps means that malleable iron will not be used much longer for couplers, and an important improvement may gradually be brought about by the general use of cast steel. That change seems to be coming about without a conflict of interests. Possibly at the coming meeting of the M. C. B. Association, the coupler committee will indicate in some manner a preference for steel couplers even if no definite action is taken at this time. It would be no more than keeping pace with the best practice. It will be remembered, the Association specifies a severer test for a cast steel coupler than for a malleable iron coupler and this could possibly be modified now that opinion is so much more favorable to cast steel than it was at the time the specifications were drawn. As the shocks received in service have no reference to the material used, the logical thing is to have but one set of requirements for coupler tests.

The gradual abandonment of the malleable iron coupler may be put down as one step in the development of greater strength. Another important step is the enlargement of the dimensions. This does not mean a change in the contour lines, but simply that the depth of the coupler face and knuckle is increased, the shank is enlarged and the whole face of the coupler is moved forward so that more metal can be put in the head. These changes in whole or in part have been embodied in some recent coupler designs especially intended for use with large capacity cars, but it is not clear why the larger couplers should not be used on the small cars as well. It is apparent that these enlarged couplers will couple with the present M. C. B. standard and can gradually be got into service by applying them in renewals and to new equipment. The change will be brought about gradually and in ordinary course of business. The increase in these dimensions is another point which the coupler committee will doubtless take up before long and some definite action would tend toward uniformity.

Closing the pin hole and the link slot of the knuckle will materially increase its strength and ability to resist wear. This has already been done by some roads, and if it were not for the difficulty encountered in moving cars on and off car ferries concerted action might be taken at once. A device for coupling solid knuckles on sharp curves is easily arranged. Roads which are not hampered with car ferries seem to be warranted in adopting solid knuckles at once, leaving the roads which have car ferries to find their own solution for their peculiar difficulties.

The enlargement of the coupler and the change from malleable iron to cast steel brings the opportunity for the coupler maker to improve the design and simplify the details of the mechanism in the head. Now he can put into new designs the results of his past experience. The tendency seems to be toward larger bearing surfaces of parts and more simple and more effective locks and toward a coupler more nearly automatic. This latter implies a lockset within the coupler head and a knuckle opener, all parts being operated from the side of the car. In some recent designs these features have been got without additional complications and where this can be done they would seem to be desirable. The present M. C. B. uncoupling gear is unsatisfactory because a close adjustment of the parts is required to transmit the unlocking movement from the lock to the handle of the uncoupling lever. The reports of the Interstate Commerce Commission have shown that these parts are not maintained in any kind of adjustment, and further the present gear is inconvenient in switching cars. What is most needed now in connection with the coupler is good designing, not invention.

The coupler situation may be summed up somewhat as follows: Couplers are being strengthened to meet heavier service conditions by the more general use of cast steel instead of malleable iron, and by increases in dimensions of the coupler which do not affect the contour lines. In addition to increasing the dimensions of knuckles in the latest designs, there is the possibility of getting greater strength and longer life by closing the pin hole and link slot, which has been done by individual roads.

In the matter of details of the coupler head and locking mechanism, improvement is tending toward simpler construction, large bearing surfaces of parts in contact, an effective lock which will remain in place without the use of a secondary lock, a lockset within the coupler head and a knuckle opener positive in its action. More care also is needed in assembling couplers. It is not to be inferred that all these things have been satisfactorily worked out but they seem to be things which will be accomplished by coupler makers as the result of competition and of changes which are now going on. However, railroads should not lose sight of the fact that a large proportion, probably the greatest proportion, of the failures of couplers and coupling gears are due directly to faulty application to cars and to the lack of inspection and maintenance, as is shown by the reports of inspections carried out on a larger scale for the Interstate Commerce Commission, which we have analyzed more than once in the last year or two.

Purdue University and Its Work in Railroad Engineering.

For several years it has happened at each succeeding convention of the Master Car Builders and Master Mechanics that committees have had occasion to acknowledge assistance rendered by Purdue University. This year is no exception to the general rule for the committee on triple valves have conducted tests in connection with the Association rack at Purdue and make acknowledgment of courtesies received, while the brake shoe committee refer to work under their direction by the Purdue laboratory. With these evidences of mutual interest between the railroad associations and Purdue it is fitting that this issue contain some account of those lines of technical work which are receiving attention at Purdue and which especially concern railroad interests.

It has long been the practice at Purdue to invite each year a considerable number of practical men to lecture before the classes in engineering, and many distinguished gentlemen have visited Purdue and have lectured upon subjects touching their everyday work. A list of those who have addressed Purdue students during the past year discloses the names of E. M. Herr, General Manager Westinghouse Air Brake Company; L. E. Johnson, General Manager Norfolk & Western Railroad; W. H. Marshall, Superintendent Motive Power Lake Shore & Michigan Southern Railway; C. R. Prouty, member of the Interstate Commerce Commission; G. M. Basford, Editor of the *American Engineer*, and H. G. Prout, Editor of the *Railroad Gazette*.

The trend of things at Purdue is disclosed also in the character of thesis subjects assigned. For example, the list this year includes: A Study of Heat Interchange in Locomotive Cylinders Under Various Conditions of Running; Tests of Locomotive Schenectady No. 2 Under Different Conditions of Speed and Cut-Off to Determine the Effect of Polished Cylinder Walls and Ends; Experiments to Determine the Effect of Duration of Test Upon the Accuracy of Results in Locomotive Testing; The Master Car Builders' Code for Testing Air Brakes; A Study of the Action of Air in the Air Brake Train Pipe Under Various Conditions of Service; Tests of Brake Shoes for the Master Car Builders' Committee; Design of a Dynamometer Car; A Study of Some Phases of Combustion in a Locomotive Boiler; Comparative Tests of a Metropolitan and a Simplex Locomotive Injector. The list as given is a partial one, for of course not all the subjects are in railroad work. Thesis subjects at Purdue are carefully outlined in writing before they are assigned, the result being that students thus aided are frequently able to develop important problems in research. The nature of some of the investigations which have been in progress during the past year is sufficiently indicated by the subjects given. While we are not permitted at this time to discuss results, we were interested in learning that the experiments to determine the effect of duration of test show that upon a testing plant a good degree of accuracy can be had even though the tests are comparatively short. The significance of this statement will be apparent when it is remembered that common practice in connection with stationary engines requires that tests persist for many hours. A locomotive on a testing plant is really a stationary engine, but it was quickly shown by the tests referred to that because of the high power at which it is worked long tests are not necessary, the practical results derived from a test of fifteen minutes being identical with those obtained from tests of several hours' duration.

The course of study at Purdue has for years contained railroad subjects. Thus, in the Civil Engineering Department, railroad surveying, construction and maintenance, railroad structures, water service, track materials and signaling have all received attention. In the Department of Mechanical Engineering locomotive testing, locomotive performance, operating and maintenance, train brakes and signals have had a place. The new catalogue shows that beginning with next September there is to be offered to all Senior students in Mechanical Engineering a new line of work to be known as locomotive and car design, and, as has been stated in our news columns, the administration of this course is to be under the direction of Mr. William Forsyth, whose high standing as a mechanical engineer with long experience in railroad service is a sufficient guarantee of the value of the course.

Our columns also have already made reference to the plan which has been formulated at Purdue for preserving a collection of typical locomotives. Recognizing the fact that certain classes of engines which have long been in service on American roads are now giving way to new and heavier machines and that in the natural order of events the old will be converted into scrap, Purdue has undertaken to collect and preserve typical machines wherever she can find them. It is not asked that roads having engines which should be preserved transfer their property, but merely that such engines be deposited for safe keeping with the University, subject at all times to the order of the owner. This plan, which is as liberal as it is commendable, will no doubt result in the preservation to future generations of many relics which otherwise would entirely disappear.

A matter now in its initial stages of development concerns a track laboratory and museum. Purdue already has a track about 8,000 ft. long, which serves to carry traffic from the Lake Erie & Western Railroad to the laboratories. The location of this track is almost entirely upon the University grounds. The proposition is to establish and maintain this line as a track museum and laboratory. The plan provides for having it laid off into short sections each of which will present some characteristic practice in track maintenance. In this manner different materials employed in ballasting, different weights and styles of rails, ties of various materials and such special equipment as rail joints, rail braces and tie plates will all be given a place. The track thus installed will serve three purposes, namely, to carry traffic, including about 2,000 tons of coal each year; as a laboratory in connection with which students in Civil Engineering will be given instruction in track maintenance and as a museum presenting in its makeup a great variety of different standards. The maintenance of a passable track is under any circumstances considered necessary and to this the Purdue trustees are already committed. The embellishment of this track in the manner indicated will be undertaken when a special endowment sufficient to provide for its permanent maintenance can be obtained.

It appears that the $5,000,000 which the State of Massachusetts appropriated in 1890 toward the abolition of grade crossings is about used up. The city of Newton has lately applied to the Superior Court, under the law, for an order directing the abolition of certain crossings in that city, but the railroad company, the Boston & Albany, makes objection on the ground that the work that has been done under the law (with that now in progress or soon to be begun, under orders already approved) will exhaust the state fund. The New York, New Haven & Hartford has made a similar answer to an application from the town of Walpole. As the state has almost uniformly paid one-fourth of the cost of the improvements that have been made in connection with crossing abolition, it would appear that the total amount spent or to be spent in the state for this purpose in 10 or 12 years has been approximately $20,000,000; and to this must be added about two millions which has been spent under special laws applying to particular places.

The locomotive enginemen and firemen in France have a union which has been making demands, directed, apparently, partly to the employing companies and partly to French Parliament. Among the demands are: At least one day of rest in ten; twelve days' vacation every year; a pension equal to half their pay when at work after 25 years' service, and in all cases after reaching the age of 50, when, they say, a man working on a locomotive is worn out!

Manufacturers of railroad materials in France complain of a plentiful lack of orders. To prepare for the World's Fair traffic unusually large additions to rolling stock, etc., were made before 1900, so great that the French works were not able to supply all the demands and many contracts were let in foreign countries. Now, naturally, the railroads have few orders to give. In many respects a World's Fair seems to be a curse to the country where it is held—witness 1877 and 1894 in this country.

Altoona Notes.

(*Continued from page 413.*)

and all of these three were from the same maker, two were from the same heat and all were applied within two weeks of each other. This statement is not intended to include breakages that have occurred as the result of overheating or from running over couplers that have fallen upon the tracks, but only to breakage under ordinary conditions of service.

These specifications call for a stiffer axle and this requires a somewhat higher percentage of carbon. This feature received many adverse criticisms at the time the specifications were issued, and was objected to both by steel makers and railroad men.

In the physical laboratory the machinery has just been augmented by the installation of a Riehlé testing machine having a capacity of 300,000 lbs. It is well known that the staybolt has been a subject of constant investigation at Altoona for many years and that various designs for securing flexibility and avoiding breakages have had trial. Among all that have been so tried the one now being extensively applied gives promise of producing the best results. It was found that the old method of simply turning off the threads from the staybolt, leaving a cylindrical connection between the sheets, was only a partial remedy. The breakage due to the sharp angles at the root of the thread was obviated, but still the bending was all concentrated at a point just inside the sheet and fractures still continued to occur. The present improvement consists in cutting out the center so that a longitudinal section has a concave outline with the smallest diameter at the center. This distributes the bending strains so that they take place over the whole length of the bolt and are not concentrated at any one spot. This prevents distortion beyond the limits of elasticity. These bolts are being applied in quantities and special machinery for making them has been installed. In fact, so much expense has been incurred in arranging for the work that it looks as though this form of staybolt would supersede all others and be the standard for some time to come.

National Convention of Railroad Commissioners.

The thirteenth annual convention of Railroad Commissioners was held at San Francisco June 5 and 6. The committee reports were given in the *Railroad Gazette* last week, page 377. We are able to give a brief report of the meetings, based on accounts published in the San Francisco daily papers. The number of commissioners and secretaries in attendance was about 60, including one woman, Miss Mary F. Hadrich, Private Secretary to Commissioner Osborn, of Michigan, who appeared as the commissioner's representative. Commissioners were present from 23 states and there were representatives of the Interstate Commerce Commission, two delegates from the Association of Railway Accountants, the Lieutenant-Governor of Pennsylvania, the Attorney-General of South Dakota, the President of the National Association of Shipping Clerks, and many others, including wives and friends of members.

Mr. Lindly, of Illinois, presided, and the members were welcomed to California by Mr. Laumeister, one of the commissioners of that state. One of the first resolutions offered was one to admit to membership in the convention not only the accounting officers of the railroads, but also the civil engineers. This led to propositions to admit statisticians of the various state boards as well as other subordinate officers. After considerable discussion the question was referred to a committee.

The report of the Committee on Legislation was unanimously adopted. The report favoring uniform classification of freight for the whole country was briefly discussed, but was laid over until next year without action. Mr. Sturgis (C., B. & Q.), of the Accounting Officers' Association, spoke of the difficulties in the way of making one uniform classification, and suggested that before acting on the subject railroad traffic men should be consulted. Mr. Prouty (I. C. C.) called attention to the fact that the arbitrary enforcement of uniform classification would unfavorably affect the revenues of the transcontinental railroads which have to meet water competition. The commission had never advocated uniform classification. The railroads had tried to make one, but a single dissenting railroad would prevent its adoption.

Mr. Hennessy's report on safety appliances was briefly discussed and referred to the next convention. Mr. Chadbourne (Me.) strongly opposed the views presented. Mr. Moseley (I. C. C.) said that the railroads had been active in their efforts to introduce safety appliances and that it would be unfair to take action at this time on information based on a newspaper report.

Mr. C. J. Lindly, of Illinois, was re-elected President and Mr. Moseley Secretary. The next convention will be held at Charleston, S. C., Feb. 11, 1902.

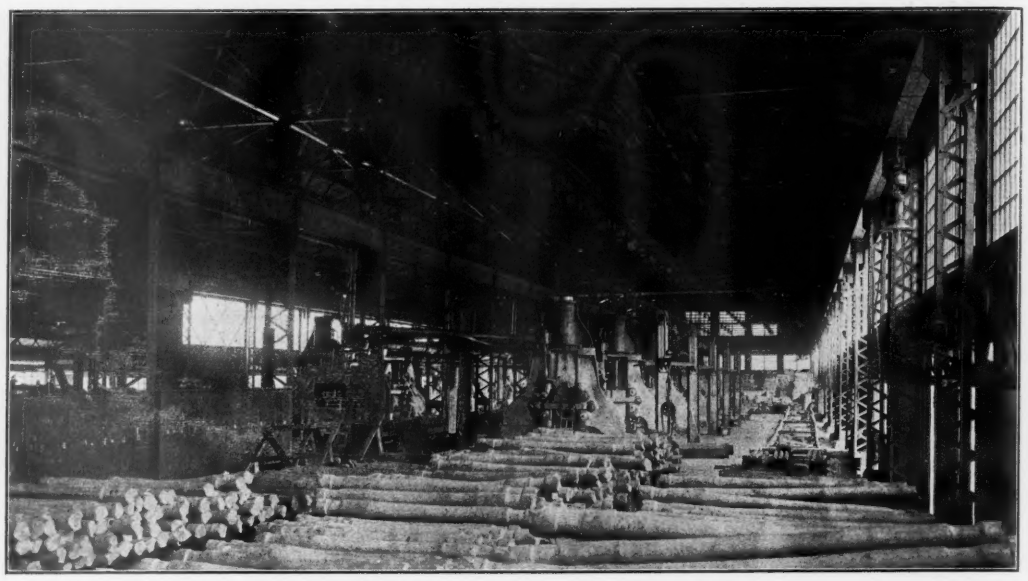
The members and others attending the convention took various pleasure excursions in and around San Francisco, including one to Mount Tamalais.

The Howard Axle Works.

Two years ago ground was broken for an extensive addition to the Homstead Steel Works at West Homestead, near Pittsburgh, Pa., the addition to accommodate the most extensive axle works in the world. The first axle was forged April 23, 1900. In the original designs the capacity of this plant was rated at 1,000 axles a day, but there is a record output of 1,300 axles in a single day. Even this rate seems to be insufficient, and improvements are in progress to raise the capacity to 1,500 axles a day. The principle item of this improvement is the addition of another heating furnace, of which there are now two.

The main building is 1,000 ft. long and 100 ft. wide. The furnaces and machinery are so arranged that the billets are received at one end of the building, and are passed on to the other, where they emerge as the finished product.

The billets are received from the mill at the northwestern end of the building, where they are unloaded by an electric traveling crane, where the hoist is a magnet. This is brought down into contact with the billet and the current turned on. No other tackle is required, and, when the billet has been put in position in the stack, the breaking of the circuit severs the connections. There are six electric traveling cranes on the premises of 10 tons capacity each, built by the Morgan Engineering Company. The capacity of these cranes is somewhat in excess of the actual demands of an axle shop, but the excess serves as a means of facilitating the handling of the work. Two of these cranes are at the receiving end of the building; two can be used to serve the hammers and two serve the lathes at the finishing end of the shop.

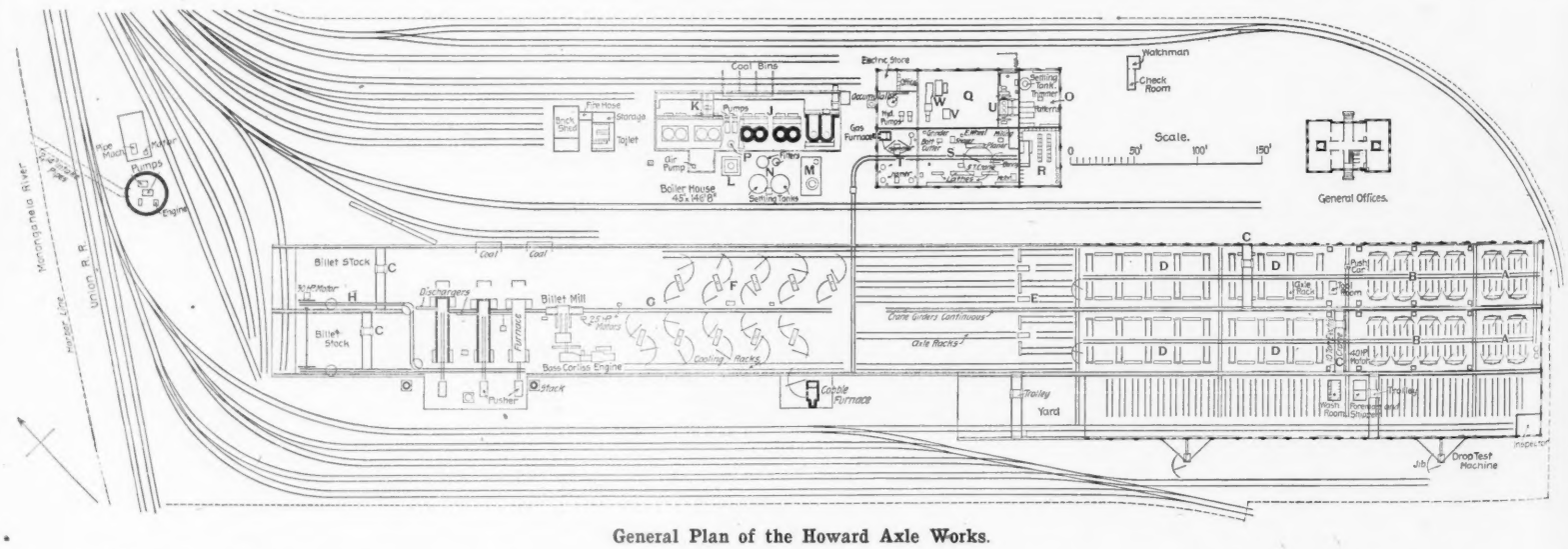


Forging Shop—Howard Axle Works.

As the billets are unloaded from the cars they are sorted, stocked and held ready for use. When needed they are again lifted by a magnet hoist and placed on a conveyor, by which they are carried to the charging end of the heating furnaces. The latter is of the Garrett-Cromwell continuous type, and has a charge capacity of 50 billets. These billets are carried downward by a hydraulic pusher, which moves the whole charge, dropping one billet at a time upon the hearth, where it is allowed to soak until it is required for the hammers. As a hammer finishes its work the fact is signaled back to the furnace by means of a colored light, and another billet is sent to it at once.

The drawing from the furnaces is done by hydraulic discharging machines, by which the billets are pushed out on to a let-down device from which it passes to the tables and conveyor, by which it is carried to the continuous roller mill.

This mill is 24 in. in diameter, and is fitted with five passes adapted to different sizes of material for different sizes of axles. As the billet comes down on to the conveyor it is guided to the proper pass by a switch. By means of two sets of rolls the billet is converted from a square to a round blank. As the blanks leave the rolls

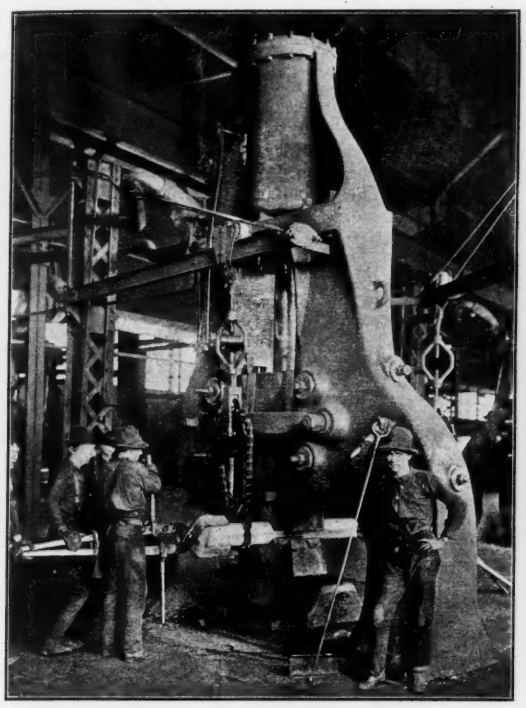


General Plan of the Howard Axle Works.

AA ..... Eight turning lathes.
BB ..... Sixteen-wheel seat journal lathes and Whiting F. E. Co. 1,500 lb. pneumatic jib cranes.
CCC ..... Ten-ton electric traveling cranes, Morgan Engine Co.
DDDD ..... Twenty-eight cut-off and centering machines.
E ..... Axle straightening machines.
F ..... One-ton jib cranes and 7,000 lb. steam hammers.
G ..... Hammer billet conveyor.
H ..... Yard billet conveyor.
J ..... Ten Cahall vertical boilers, 250 h.-p. each.
K ..... McMyler coal elevator and conveyor.
L ..... Weiss condenser.
M ..... Water cooling apparatus.
N ..... Water softening plant.
O ..... Carpenter shop.
P ..... Vacuum heater.
Q ..... Engine room, 45 ft. x 80 ft.
R ..... Store room.
S ..... Machine shop, 45 ft. x 80 ft.
T ..... Blacksmith shop.
U ..... 650 h.-p. 25 in. x 30 in. Westinghouse gas engine.
V ..... 9 in. x 9 in. x 9 in. air compressor.
W ..... 650 h.-p. 18¾ in. x 36 in. x 33 in. Buckeye engine.

they are ordinarily carried by a roller table to the hammer, to which they are delivered by a special switching apparatus. Sometimes, however, the blanks are picked up, as they leave the rolls, by tongs slung from the overhead traveling crane, and are carried to the hammer in that way.

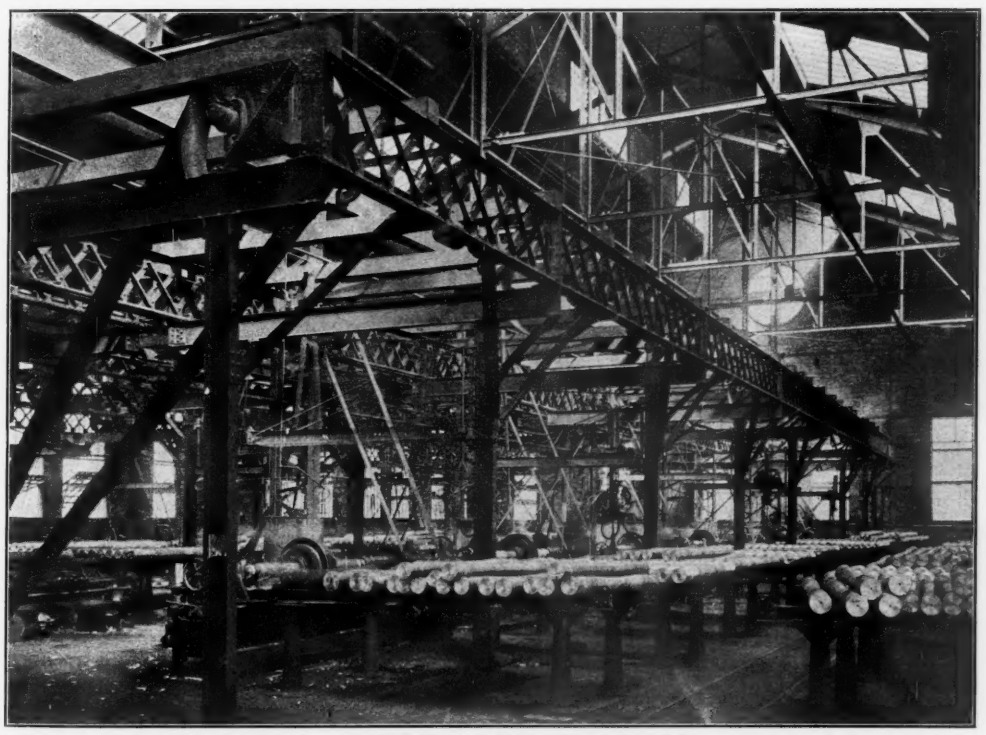
The switches for the delivery of the blanks by conveyor are handled from a pulpit located near the center



Forging Axles—A 7,000-lb. Hammer.

of the hammer floor, and controlled by a man who can see each hammer.

Each hammer is provided with two gib cranes. The hammers themselves are of 7,000 lbs. capacity, and are worked by two gangs each. The blank is delivered to the crane nearest the furnace, and the gang operating it proceeds at once to hammer down one end of the axle. As soon as this is done, it is passed beneath the hammer and held to the anvil while the tongs for the other crane are being attached. The gang of the second crane then proceeds to hammer down the other end. In this way each gang is resting for about one-half the time while the hammer is working continuously. The average time required for the hammer work on an axle for a 100,000



Section of Finishing Shop—Howard Axle Works.

lbs. capacity car is about seven minutes. There are ten of these hammers, which, if working at this rate for ten hours, would have an output of something more than 850 axles. Of course, for the smaller sizes a shorter time is required.

In the manipulation of these axles under the hammer, the use of water for the removal of the scale is dispensed with, and in its stead a jet of steam is employed. This does the work as efficiently as the water, and does not make a puddle.

When the axles have been forged they are placed on cooling racks, whence they are taken by the traveling cranes to the straightening presses, of which there are three. From this point on there is little that is novel in the methods of doing the work other than the large quantities handled. The crop ends are cut off, and the axles are centered in tools that are used in all railroad shops. They are then turned, where the order calls for it, in the usual form of axle lathes. But the magnitude of the industry holds our attention. There are 28 cutting off and centering lathes, 16 axle lathes, that are used for turning journals and wheel seats, and 8 center lathes. All of these are driven by electric motors operating in small units. The axles are handled at the lathes by pneumatic hoists carried by overhead trolleys.

When the machine work has been done the axles are loaded on transfer cars and pushed to the loading shed. In addition to the main structure there are several auxiliary buildings. There is a pump house, a building containing storage rooms and toilet arrangements.

The boiler house is 45 ft. x 146 ft. 8 in. long, and contains 10 250 h.p. Cahall boilers that are fitted with the Mansfield chain grates. Next to the boiler house is the engine house and machine shop. The whole building is 144 ft. x 90 ft. The engine room occupies the central portion of one side, and contains two 400 kilowatt Westinghouse dynamos. They are both dircet connected. One is driven by a 60 h.p. 18¾ in. x 36 in. x 33 in. Buckeye engine and the other by a 25 in. x 30 in. Westinghouse gas engine of the same rated capacity. The engine room also contains a 9 in. x 9 in. x 9 in. air compressor. One end of this building is occupied by the blacksmith shop and pump room. Each measures 32 ft. x 45 ft. The latter contains two Worthington duplex pressure pumps of 12 in. x 4¾ in. x 12 in. dimensions, with a 16 in. x 8 ft. accumulator.

The blacksmith shop and machine shop, which occupy a portion of one side of the building, are fitted with the ordinary tools of such shops, and are prepared to do the necessary repairs about the plant.

The southeast end of this building is occupied by the storeroom, office and pattern and carpenter shops. The general offices are in a separate building of brick that is removed from the shops.

Straightening and Finishing Shops—Howard Axle Works.

The Life of Locomotive Tubes.

We recently asked a number of railroads as to their experience with cold-drawn steel boiler tubes in locomotives, and while none were then prepared to furnish any definite information as to the relative performance of iron and steel tubes, the correspondence brought out some interesting points as to the great variation in the life of tubes in service, chiefly due to the quality of the water used. Portions of these letters are given below. Those who are working on water purification for locomotives will find a number of interesting facts. It is also evident that it is going to be difficult to tell anything about the relative worth of iron tubes and cold-drawn steel tubes from the results of service tests.

Mr. C. H. Quereau, Asst. Superintendent of Machinery, Denver & Rio Grande.—In a general way I am impressed that the chief element in their duration is the service they are compelled to perform, including the quality of water used. I have seen tubes which have been in an engine for 15 years and were then in first-class condition, the water having no scale-forming material in it. On the other hand, where there is considerable alkali and incrusting solids in the water used a set of tubes will frequently fail in three months.

Mr. B. Haskell, Superintendent of Motive Power, Pere Marquette.—The life of flues on the Pere Marquette is all the way from 5 to 9 years, due to differences in character of the water we use. We get on an average 15 months' service from tubes before they are removed. This refers to charcoal iron tubes, which is the only kind that I use in our engines. Our engines average about 4,500 miles per month. I find that the life of tubes also depends upon the service of the engines. For instance, take heavy freight engines when loaded to their full capacity with excessively hard-pulling trains and severe weather, the flues are often started on the road, calling for frequent rolling and calking. This, of course, shortens the life of the tubes.

Mr. W. Garstang, Superintendent of Motive Power, Cleveland, Cincinnati, Chicago & St. Louis.—In going over our records I find that the average life of charcoal-iron tubes in passenger service, which includes both local and through fast passenger trains, averages 75,000 miles; in freight service 58,000 miles. The above record is taken from engines with shallow fire-boxes. I find that the tubes in engines with deep fire-boxes make 15 per cent. greater mileage than tubes with shallow fire-boxes.

On account of the bad quality of water on our line we use a No. 11 gage tube, weighing about 2¾ lbs. per foot. We continue to piece the tube until it is reduced in weight about 1 4-10 lbs. We find that on an average we can piece tubes ten times before they are condemned, getting about the same amount of mileage from the tubes after each piecing that we did when they were applied new.

Mr. D. Van Alstine, Master Mechanic Chicago Great Western.—The average time that tubes run on this road is about 15 months, and the life of a tube is about 7 or 8 years. My experience with steel tubes is thus far limited to six months' service in one engine. So far they have done well. As to the size and age of tubes, we believe we have less trouble with 2-in. tubes than with larger ones, and also that No. 11 gage stays tight longer than No. 12. The swaging of flues at the back flue sheet has been a failure with us, and we consider it is more a question of spacing than anything else, and that the important point is to keep the tubes far enough apart to permit a good circulation. From my experience I do not consider that the length of the tube has much to do with its leaking, but I do believe that the length of the fire-box has considerable to do with it. The longer and shallower the fire-box the greater the liability to

leaky tubes. With a deep fire-box we think we have less trouble from leaky tubes by using a brick arch, but with a shallow fire-box we find no difference.

Mr. Thomas Paxton, Atchison, Topeka & Santa Fe.—I do not know of any single feature of locomotive maintenance subject to wider variation in practice and results than tubes. The leading factor in determining the life of tubes is the kind of water used, the nature and quantity of the incrustant usually determining whether the life of the tubes is to be long or short at each setting. I have handled engines on the Middle Division of the Santa Fe in freight service where it was difficult to get 18,000 miles per setting of tubes. I have on the west end of the Chicago Division got 80,000 miles per setting, and I believe that our records will show that between other parts of the system even greater differences exist.

In localities where the feed water does not produce pitting or grooving of the tubes, they are worn out principally by the cutting action of the cinders drawn through them. Even this is a widely varying quality. I found the fuels used on the Middle Division to be not half so severe in their cutting action as those found on the Chicago Division. To illustrate: During the seven years I had charge of the Middle Division I never found it necessary to put shields on steam pipes or Rushforth heater pipes in the front ends. On the Chicago Division this is compulsory on account of sparks cutting holes in the steam pipes in a few months, and I have known them to bore holes through the Rushforth heater pipes in a very short time.

The life of a set of tubes, or in other words, the wear that can be got out of the tubes from the time they are put into service until they are removed as being too light, will vary widely for the above reason. While on the Chicago Division I scrapped a large number of tubes that were received with a lot of new 10-wheel engines in that territory seven and eight years before, and they had been running in the same engines subject to periodical resettings during all that time. I have been told that there are sections of the Santa Fe where pitting causes the condemnation of flues in a year or less. No case of this kind, however, has come under my personal observation.

To sum the whole matter up, it may be said that the life of tubes either between settings or covering the whole period of their use, is wholly dependent upon the are subject. Further, in service these conditions are so widely varying as to prevent the formation of useful rules whereby one railroad or locality may profit by the experience of another.

TECHNICAL.

Manufacturing and Business.

The Harrow Spring Co., of Kalamazoo, Mich., has contracted with Wm. B. Scaife & Sons, of Pittsburgh, Pa., for a number of steel frame structures. The main building will be 290 ft. long, 90 ft. wide and 32 ft. 6 in. high.

The Philadelphia Pneumatic Tool Co. has opened an office at 527 Marquette Building, Chicago, in charge of its Western representative, Mr. A. G. Hollingshead.

The Powers Regulator Co., Chicago, has furnished its temperature controlling apparatus to the Grand Trunk, Canadian Pacific, Canada Atlantic and the Intercolonial Railway of Canada. These roads report that the apparatus is working satisfactorily. The Chicago & Northwestern and Lake Shore & Michigan Southern, after a trial of two years, have adopted the Powers system and other roads have it on trial.

The Melan Arch Construction Co., of New York, and Edwin Thatcher, lately of Paterson, N. J., have consolidated under the name of the Concrete-Steel Engineering Co., with general offices in the Park Row Building, New York. The business of the company will be planning and building bridges and other structures of concrete-steel construction.

The Powers Regulator Co. reports that among others the following roads recently equipped some of their passenger equipment with the Powers system of automatic temperature control: Delaware & Hudson, Delaware, Lackawanna & Western; Pennsylvania, Michigan Central, New York, Ontario & Western; Grand Trunk, Canadian Pacific, Chicago & North-Western, and New York Central.

Zincre—A Wood Preservative.

Readers of the *Railroad Gazette* are familiar with the Burnettizing (zinc-chloride) and Bethellizing (dead oil of coal tar creosote) processes of preserving wood. They have been used successfully since 1838. About 1870 Jules Rutgers conceived the idea of uniting the two methods; but, while the results were satisfactory, the scheme was not then commercial because of the way in which the processes were used. The American Paint Co., New York, has perfected the chemical combination of the Burnettizing and Bethellizing processes and has secured control for years to come of the supply of the less abundant portion of the crude material and essential to the manufacture of "Zincre." In this new preservative the best qualities of both the old processes are offered, with the objectionable features eliminated, and in a form so convenient for application that an ordinary laborer with a paint brush, or an open tank or vessel, in which to dip the wood, is all the machinery required. Timber can be treated at the place of use, after framing, which makes the material of practical value in the building and preservation of cars, bridges, trestles, platforms, buildings of all kinds and other structures of wood, liable to decay.

Steam Engines for Egypt.

A public competition has been opened in Upper Egypt for the delivery of four vertical compound high-pressure engines to work centrifugal pumps for irrigation. The contract will also include the delivery of six steam boilers for use in connection with the engines. All must be delivered at Esta, on the Upper Egyptian Railway. The plans may be examined at the bureau of the Inspector-General of the Irrigating System for Upper Egypt, at Cairo, and all offers must be submitted to him by June 25, 1901.

The Gold Straight-Port Coupler Decision in Canada.

The Court of Kings Bench, on appeal, has decided that the use of the Gold straight-port coupler for steam heating is lawful in Canada. This is the final result of a long contest between the Gold Company and the owners of the Sewall coupler. In detail, the Court's opinion is that the Sewall invention includes, as an essential element, the hinge-joint as a part of the locking devices through which gravity acts to keep the coupler heads together, and that the hinge-joint is the basis of the automatic uncoupling; that all the claims of the Canadian Sewall patent, and particularly the third claim, include the hinge-joint as an essential element thereof; that, the claims of the Sewall Canadian patent being combination claims, there can be no infringement thereof except by employing the entire combination, and that inasmuch as the Gold straight-port coupler does not employ the hinge-joint nor any equivalent thereof the Gold coupler does not infringe the Sewall patent.

Under this decision of the Canadian Court railroads and all other users of steam hose-coupling are entitled to purchase and use the Gold straight-port coupler with its rocking gasket, which secures a steam-tight joint without the necessity for the use of the hinge-joint.

The Consolidated Car-Heating Company, owners of the Sewall patents, have appealed from this decision to the Privy Council.

Estimates for a Pontoon Bridge.

Mr. S. A. Williams, Secretary of the Commercial League of Ft. Smith, Ark., would like to know the probable cost of a pontoon bridge to be laid in the Arkansas River. The bridge will be from 3,000 to 3,500 ft. long.

American Locomotive Company.

The American Locomotive Co. was incorporated in New York State on June 10, with a nominal capital of $50,000. The directors are: Dwight W. Morrow, Hamilton H. Durand, Graham Sumner, Alexis T. Bartlett, Alfred L. Curtiss, Charles Fay, Hugh A. Bayne, Robert Grattan, of New York city; Thomas M. Day, Jr., of Plainfield, N. J.; J. Clinton Walker, of Brooklyn; John J. Treacy, of Jersey City. The general offices of the company will be in Schenectady, N. Y.

Green for All Clear on the Erie.

The Erie road is preparing to change the lamps on its fixed signals so that at night the all-clear indication will be given by a green light. Yellow will be the caution color. On the Delaware Division, from Port Jervis to Susquehanna, the change will be made within a few weeks. At the same time the company will have the semaphores on this division, of which there are 208, equipped with lamps which revolve on a vertical spindle, thus doing away with spectacles in the semaphore arms. The lamps are connected by gearing to and move with the signal arm. The distant signals will have yellow lenses made by the Corning Glass Company.

On the New York, Susquehanna & Western, which is controlled by the Erie, the revolving lamps and the yellow glasses have been in use for about a year past.

Automatic Block Signals on the New York Central.

The fact that the New York Central will soon install automatic electric semaphores on the southern end of the West Shore Division was recently noted in these columns. The company has now given to the Union Switch & Signal Company a second order for the same kind of signals; these are to be put up on the line of the Harlem Division between White Plains and Mount Kisco, fifteen miles. This line is now single track, but a second main track is nearly finished. The company is also introducing automatic semaphores at a number of places on the line between Buffalo and Niagara Falls, where controlled manual signaling is in force but where the block sections are too long.

Pressed Steel Cars.

Every day sees a large shipment of steel cars from the works of the Pressed Steel Car Company, and the company now has orders sufficient to keep the 10,000 men on its pay rolls busy for some time to come. During the last week of May 400 hopper coal cars, similar to the 600 cars built and shipped to them during the early part of the year, were ordered by the Chesapeake & Ohio. Another order received during the same period was from the Algoma Central Railway for 50 ore cars of 120,000 lbs. capacity. The total number of cars shipped since the industry began four years ago is 40,578. At the present rate of production the company will build this year nearly as many cars as since the beginning. During May the total number built and shipped was 2,705. This average has been kept up for several months, and the officials believe that in the future the average will be even greater than it has been in the past. In addition to the cars built by this company, there is a large output of bolsters, truck frames, center plates, brake-beams, etc., and in May alone the consumption of steel amounted to over 40,000 tons.

Military Traction Wagons.

The British War Office has issued an advertisement offering prizes for the best "self-propelled lorry" for military purposes. These traction wagons must be capable of being used on rough roads and to some extent across country. They must be able to go wherever a country cart can go and through an opening 7 ft. 6 in. wide. They must be capable of carrying a net load of at least three tons on the lorry and two tons on a trailer, exclusive of fuel and water. They must be able to make eight miles an hour with load on fair roads. There is no restriction as to the nature of fuel or class of engine, except that oils under 75 deg. Fah. flash point must not be used. Three prizes are offered for these machines, namely, £500, £250 and £100. The trials will begin in England on Dec. 4, and will be thorough. Any of our readers who may be inclined to enter into this competition may find further particulars in our advertising columns, and may get still further information by addressing Colonel Gerald Kitson, Military Attaché, British Embassy, Washington, D. C., or by application to the Secretary, Mechanical Transport Committee, War Office, London.

The Ferguson Heater and Kindler.

The Ferguson heater and kindler, which was put on the market about a year ago by Mr. W. M. Simpson, Chicago, has been found useful for a number of purposes besides kindling fires in locomotives, for which it was originally designed. The apparatus consists of a tank containing oil, a hose coupling for connection with the compressed air system, a hose terminating in a nozzle for spraying the mingled oil and air, and a valve for controlling the relative proportions of oil and air. The tank is mounted on a truck, so it can easily be moved from one point to another. Tests have shown that with this heater a steel tire can be removed or put on a driving wheel center in nine minutes without removing the axle from the locomotive. For this operation about two quarts of crude oil is required. It has also been used extensively for heating bent locomotive frames, replacing more elaborate devices which have been in use. For straightening heavy parts the heater has in some cases been added to the wreck car equipment. Another use for which it seems to be particularly adapted is in the repair of steel freight cars. The longitudinal members of these cars are usually bent more or less in wrecks, and the portable heater has been found very convenient in straightening the bent parts without removing them from the car. One of these heaters will be exhibited at the Saratoga convention.

The Launch of a Tunnel.

A distinctly novel launch took place last Saturday at Mr. Lewis Nixon's Crescent Shipyard, being nothing less than the launch of a tunnel 250 ft. long and 12½ ft. in diameter. This remarkable craft consists of two concentric steel cylinders one within the other, with an 18-in. space between them. This space will eventually be filled with concrete, but at the time of the launch was only about half full. The tunnel will be towed to 39th street and East River, there to be sunk to take in water for the condensing plant of the Edison Electrical Company. The tube is built for Messrs. Knight & Landé, Mr. Landé being, as we understand, the designer and principal patentee. Mr. Knight is Mr. Walter H. Knight, well known as a mechanical and electrical engineer. The designs for this kind of tunnel first took form, we believe, as part of a project for a railroad tunnel across the North River. Meanwhile, this opportunity to put in a water tunnel will give useful experience and perhaps the railroad tunnel will come later.

The London Underground.

It appears to be a fact that Mr. Yerkes has got a considerable interest in the Metropolitan District Railway (underground) and proposes to equip it for electric operation. Mr. James Staats Forbes, chairman of the Metropolitan District, said recently at a stockholders' meeting that Mr. Yerkes and his associates had guaranteed their good faith by buying up one-half the common stock, and that the work of changing to electric operation would occupy two years. He said that the Americans undertook to find the money and to do the work. The agreement provides for the formation of an electric traction company to work the road and the company undertakes to convert the line without interfering with operation. We judge that the company is to be called the Metropolitan District Electric Traction Company and it is said that the Maryland Trust Company of Baltimore will be the American financial agent.

THE SCRAP HEAP.

Traffic Notes.

The Grand Rapids & Indiana has been ordered by the state of Michigan to reduce its passenger fares to 2½ cents a mile, its passenger earnings having increased so as to bring the company within the 2½-cent class, under the law.

The passenger agents of the Trunk Lines have declined to make further reductions in fares to the Pan-American Exposition, though the Exposition managers state that they cannot make their enterprise fairly profitable unless railroad fares are lowered.

Chicago reports say that Mr. J. V. Mahoney, Commissioner of Transportation of the Pan-American Exposition, and formerly Chairman of the Sioux City Traffic Bureau, is to succeed Mr. Courtright as Chairman of the Western Freight Association, Mr. Courtright being in ill health.

A press despatch from Athens, Ala., says that merchants of that town, dissatisfied with the rates charged by the Louisville & Nashville, which is their only railroad, are hauling goods from Huntsville and Belle Mina, on the Southern Railway, thereby making a saving in the cost of transportation. Huntsville is about 25 miles from Athens, and Belle Mina, which is not a competitive point, is about 12 miles.

The Kentucky Court of Appeals has affirmed the decision of the Lower Court against the Illinois Central for violation of the long and short haul law of that state, the penalty being $200. After the offense the railroad company secured permission from the State Commission to disregard the requirement of the law, but the court holds that this action of the Commission did not relieve the railroad company from the penalty of its past offenses.

Mr. D. B. Martin, of the Baltimore & Ohio, who was chosen to arbitrate the question of passenger fares from Kansas City eastward, has decided that for tickets on its train No. 8 the Wabash must increase its fares to the basis in effect by the so-called standard lines. Such advanced fares must be continued in effect as long as the present train service, equipment, schedule and general conditions of train No. 8 are continued, in connection with the Delaware, Lackawanna & Western and in the Western Passenger Association territory.

Forged Canada Atlantic Clearances.

"Clearance papers"—certificates of service with a railroad company—purporting to have come from the Canada Atlantic Railway, and to have been signed by M. Donaldson, Supt., are being presented to railroad officers in considerable numbers in the southwestern states. One which was recently given to an officer of the Galveston, Harrisburg & San Antonio, has been shown to us. It is filled out by typewriter, and purports to give the certificate of B. J. Ward, employed as conductor for four years. The persons who got up the blank have taken little pains to exactly imitate the genuine blank of the Canada Atlantic. It is headed "Ottawa, Canada," not "Ottawa, Ont.," and the signature bears no resemblance to the genuine signature of Mr. Donaldson. The imitation of the dating stamp is printed in a different color from that of the rest of the document, but appears to have been put on with a printing press, the border lines being ordinary light-face printers' rules. In the written portion the word Ottawa is spelt "Ottowa," though in the printed heading the correct spelling appears.

Landscape Gardening on the New York Central.

Mr. Charles W. Leavitt, Jr., Assoc. M. Am. Soc. C. E., Civil Engineer and Landscape Gardener, of New York City, has been engaged by the New York Central & Hudson River as Landscape Engineer. We understand that Mr. Leavitt will not only lay out grounds about stations, but will also take up the problem of improving the appearance of the right of way, by reforming the banks and planting shrubbery. The report that Mr. Leavitt is to devote his whole time to the New York Central appears to be erroneous, as he will still maintain his office at 15 Cortlandt street.

Railroad Equipment for Italy.

The plan for an increase in the rolling stock of the Mediterranean Railway System of Italy has been approved. This plan contemplates as additional equipment 30 locomotives, 40 passenger cars (second-class), 90 freight cars, 46 tank cars, 50 freight cars (flat) and 18 bogie cars, at a total cost of $1,782,000. Replacements will call for 32 locomotives without, and 14 with, tenders; 2 parlor cars, 30 passenger cars (first-class), and 50 third-class, 2 bogie cars and 70 closed and 30 open freight cars. For these, $1,474,500 will be appropriated. Advertisements for bids will be published soon. The material must be delivered within from seven to ten months. Eight hundred and fifty cars will also have to be provided to replace those which heretofore have been leased. The Government, however, has not yet arrived at a decision in regard to this last proposition, but will have to do so shortly, as the leases expire this fall.

The McDonough Disaster.

In the first suit which has been tried against the Southern Railway for damages resulting from the passenger train disaster at McDonough, Ga., in June, 1900, where thirty-five persons were killed, the jury has decided in favor of the railroad, holding that the disaster was due to the act of God. The trial has occupied about six weeks. About twenty suits have been filed against the road, claiming, in the aggregate, about $250,000. It is said that half of these suits have already been settled out of court. The plaintiff in the suits now decided, whose counsel is Mr. Hoke Smith, will demand a new trial.

The Pressed Steel Car Company at the Pan-American.

The exhibit of the Pressed Steel Car Company at the Pan-American Exposition is in the Railroad Exhibits Building in which is also the Terminal Station. The company has fitted up a steel underframe box car as an office and reception room, and this has become a meeting place for railroad men visiting the Fair. The exhibit consists of five steel cars and a number of pressed steel car parts.

A Mail Car at Buffalo.

A most entertaining exhibit is to be found in the Railway Transportation Building. It is a Delaware & Hudson Railway mail car. It represents the acme of car building as far as postal cars are concerned, and its equipment consists of all the devices recommended by the government for use on postal cars. The car is brilliantly lighted day and night by ten Pintsch lamps, and a complement of railway mail service clerks is constantly at work sorting, distributing and dispatching all the mail collected by the Exposition branch of the Postoffice. —*Buffalo Enquirer.*

The Boston Elevated.

The elevated railroad in Boston was opened for business on Monday morning last from Sullivan Square, Charlestown, southward to Dudley street, Roxbury, about five miles. Large numbers of passengers rode in the cars early in the morning merely for entertainment, and the stations were badly crowded for many hours. It is said that from 5:30 to 9 a. m. the number of persons carried was 58,000. There was a slight collision in the afternoon at the Haymarket Square station. A northbound train which had become stalled on the grade leading from the subway to the elevated line was slowly set back to the foot of the hill to get a new start; a flagman was sent back to stop the following train, but it appears that the motorman of the backing train, depending on this flagman, or someone in his place on the rear car, to give the stop signal, did not sufficiently reduce his speed on approaching the other train. No persons were injured and only slight damage done.

LOCOMOTIVE BUILDING.

The Elgin, Joliet & Eastern is asking bids on 13 locomotives.

The Pittsburgh & Lake Erie is having two engines built by the Pittsburgh Locomotive Works.

The West Virginia Short Line is having two engines built by the Manchester Locomotive Works.

The Indiana, Illinois & Iowa has ordered 10 locomotives from the Brooks Locomotive Works.

The Missouri, Kansas & Texas is having five locomotives built by the Schenectady Locomotive Works.

The Southern Indiana has ordered two switchers and two 10-wheelers from the Baldwin Locomotive Works.

The New York, Chicago & St. Louis has ordered 10 consolidation engines from the Brooks Locomotive Works.

The St. Louis & San Francisco, as reported in our issue of June 7, has given an order to the Dickson Locomotive Works for five simple consolidation locomotives for October or November delivery. They will weigh 144,000 lbs. on drivers; will have 21-in. x 28-in. cylinders; 56-in. in diam. drivers; straight top radial stay boilers; working steam pressure 190 lbs.; 268 steel tubes 2¼ in. in diam. and 14 ft. long; Carbon steel fire-boxes. 108¼ in. long and 40¼ in. wide, and tank capacity for water 5,000 gals. They will be equipped with hammered iron axles, Sterlingworth brake-beams, Gould couplers on engines and Janney couplers on tenders, Hancock injectors, Consolidated safety valves, Leach sanding devices, Nathan lubricators, Scott springs, Johnston blow-off cocks and Westinghouse friction draft gear.

CAR BUILDING.

The Chicago City is about to order 120 cars.

The Central Vermont has asked bids on from 50 to 100 coal cars.

The Florida East Coast is asking bids on about 500 freight cars.

The American Cotton Oil Co. is asking bids on from 50 to 100 tank cars.

The Ozark & Cherokee is having two coaches built by the Barney & Smith Car Co.

W. J. Gorman & Co. is having 13 freight cars built by the American Car & Foundry Co.

The New York Central & Hudson River is asking bids on 200 flat cars of 80,000 lbs. capacity.

The Cleveland, Lorain & Wheeling, it is reported, will build 100 or 200 cars at its own shops.

The Terre Haute & Indianapolis is having two coaches built by the American Car & Foundry Co.

The Mexican Central has ordered nine first class and nine third class coaches from the Pullman Co.

The Intercolonial, of Canada, has ordered 50 freight cars from the Rathbun Co. of Deseronto, Ont.

The Cincinnati, Hamilton & Dayton is having two coaches built by the Barney & Smith Car Co.

The Mobile & Ohio specifications for 1,500 to 2,000 cars will be sent out in the course of a few days.

The Southern Pacific has ordered 30 chair cars from the Pullman Co., instead of 25, as reported May 31.

The Charleston, Clendennin & Sutton is having 50 freight cars built by the American Car & Foundry Co.

The Chicago Great Western is reported in the market for refrigerator cars and has ordered 200 stock cars of 60,000 lbs. capacity from the Pullman Co.

The American Smelting & Refining Co. has ordered 15 patent dump cars, of 100,000 lbs. capacity, from the Ingalsby Automatic Car Co., of St. Louis, Mo.

The Mexican Central has ordered from the American Car & Foundry Co. 200 box and 100 stock cars. This is in addition to the order for 100 box and 50 stock cars noted June 7.

The Colorado Fuel & Iron Co. has ordered 30 steel flat cars of 100,000 lbs. capacity from the American Steel Foundry Co., and 280 wooden and 20 steel cars of 100,000-lbs. capacity (all Ingalsby patent dump cars) from the Ingalsby Automatic Car Co., of St. Louis, Mo.

The Toledo, Peoria & Western, as noted in our issue of May 24, is having 50 cars built by the Mt. Vernon Car Mfg. Co. They are for July delivery and will have a capacity of 80,000 lbs. They will be equipped with steel axles, Shickle, Harrison & Howard bolsters, Interchangeable brake-beams, Tower steel couplers, French springs and Mt. Vernon Car Mfg. Co. wheels.

BRIDGE BUILDING.

ADRIAN, MICH.—The Toledo, Adrian & Jackson Ry. (electric) has applied to the Commissioner of Railroads of Michigan for the approval of two crossings of its line and the Lake Shore & Michigan Southern. One overhead near the city limits of Adrian and one at grade with the Fayette Branch.

AKRON, OHIO.—The Northern Traction Company (general office Akron, Ohio) is reported having plans made for a double-track steel bridge over the canal in Akron.

ANN ARBOR, MICH.—See Detroit, Mich.

BAINBRIDGE, GA.—The Georgia, Florida & Alabama Railway has let a contract to B. H. Hardoway, of Columbus, Ga., for a steel bridge with wooden approaches over Flint River on the Georgia Pine Railroad, at Bainbridge, at $65,000.

BALTIMORE, MD.—The Common Council is considering building a bridge at Exchange street at a cost of $30,000.

BATTLE CREEK, MICH.—The City Recorder is ordered to get bids on a stone and concrete bridge on North Jefferson street, to be opened July 1. The cost is about $12,000.

BINGHAMTON, N. Y.—The Lackawanna R. R., according to report, will build a plate girder bridge over the tracks at Main street.

The Lackawanna is also reported considering building a new bridge over the Chenango River at Binghamton.

CANTON, OHIO.—We are told that the County Commissioners will receive bids on June 29 for a stone bridge over Minishillen Creek, four miles from Canton. Wm. M. Reed, County Auditor. (June 7, p. 387.)

CAMDEN, N. J.—Plans for the proposed bridge over Cooper's Creek at East Pine street, for which the Board of Freeholders has appropriated $16,000, have been made by County Engineer Albertson. The bridge will cost about $25,000.

CHESTER, MASS.—Bids are wanted June 21, by the Selectmen, George H. Heapgood, Chairman, for a high truss riveted steel bridge 125 ft. long, to replace the Wait bridge over West Branch of Westfield River.

CLEVELAND, OHIO.—The city is considering replacing the old draw span on the Superior street viaduct, the improvement to cost about $500,000. It is said the Valley R. R. Co. will also put in a lift bridge to replace its structure south of the Superior street viaduct.

CONNEAUT, OHIO.—We are told that bids are wanted on June 25 for the superstructure of a steel bridge over Conneaut Creek and the Pittsburgh, Bessemer & Lake Erie R. R., by R. B. Willis, of Erie, Pa. The bridge will be about 1,740 ft. long, 40 ft. wide and 75 ft. high. Chas. Marsh, of Erie, Pa., has the contract for the foundations. The total cost of the bridge is estimated at $200,000. W. C. Culbertson is interested in the project with Mr. Willis.

CONNELLSVILLE, PA.—The City Council has passed an ordinance granting the Greenwood Bridge Co. the right to build a free bridge from Green street, South Side, across the Youghiogheny River to New Haven. (April 26, p. 290.)

DELPHI, IND.—Bids are wanted, June 20, for building five county bridges, three arches and repairing two arches. John Nevin, Chairman County Commissioners.

DETROIT, MICH.—The Detroit & Chicago Traction Co. has filed with the Commissioner of Railroads for Michigan an application for an undergrade crossing of the main line of the Pere Marquette R. R. in the township of Springwells, Wayne County. Overhead crossings of the Michigan Central are proposed on Broadway or Beakes street in Ann Arbor and at Parma. An overhead crossing of the Ann Arbor R. R. is proposed on Ann street in Ann Arbor.

DULUTH, MINN.—Bids are wanted, June 17, for a steel footbridge at Tenth avenue West, which will cost about $8,000. R. Murchison, Clerk, Board of Public Works.

FLINT, MICH.—Plans have been made by the Grand Trunk Western for its proposed overhead crossing of the tracks of the Pere Marquette in Flint. The main span will be 75 ft. long. The Detroit Bridge Co. has the contract.

FOND DU LAC, WIS.—An iron bridge will be built across the West Branch, three miles southwest of the town.

FORT SMITH, ARK.—S. A. Williams, secretary of the Commercial League, tells us he would like information as to the probable cost of a pontoon bridge over the Arkansas River at Fort Smith, to be from 3,000 to 3,500 ft. long, possibly one-half of which would have to rest upon a sand bank part of the year.

FORT SCOTT, KAN.—The Fort Scott Consolidated Supply Co. contemplates extending its electric railroad west by a viaduct on Sixth street.

KANSAS CITY, KAN.—Bids are wanted, June 21, for a steel bridge in Shawnee Township. Frank L. Holcomb, County Clerk.

KNOXVILLE, TENN.—The County Court of Greene County has decided to rebuild the six bridges over Nolachucky River that were swept away during the recent flood.

LEWISBURG, PA.—The State Legislature has passed a bill authorizing the Commissioners of Union and Northumberland counties to build a steel bridge over the Susquehanna River at Market street.

MEXICO, MO.—The City Council has passed the ordinance authorizing the Chicago & Alton and the Wabash to build a proposed viaduct over Clark avenue. (March 15, p. 192.)

MIAMISBURG, OHIO.—The County Commissioners, according to report, have decided to replace the two bridges over Great Miami River with steel spans of 150 and 204 ft. respectively, each with 20-ft. roadway. The total cost is estimated at $12,000. The Miamisburg Traction Co. will pay part of the cost.

MIDDLETOWN, IND.—We are told that bids will probably be wanted in August or September by the Muncie, Middletown & Greenfield Traction Co. for a number of bridges on the proposed line. W. L. McCampbell, General Manager.

MILWAUKEE, WIS.—An estimate of $350,000 is made for a viaduct proposed on Washington avenue over Menominee Valley. It will be about 2,730 ft. long. The city will issue bonds later in the season.

MONROVIA, MD.—The County Commissioners have decided to build a steel bridge over Brush Creek near Monrovia.

NEW YORK, N. Y.—The Board of Directors of the New York Central & Hudson River Railroad has appropriated $1,500,000 out of the surplus for the fiscal year ending June 30, 1901, towards the strengthening and renewal of bridges. This, with the two million dollars appropriated last year, will complete the work on the main line, West Shore & Pennsylvania Division, leaving only some minor work to be done on branch lines.

The Board of Estimate has authorized an issue of $500,000 of bonds for the bridge over Gowanus Canal at Ninth street, Borough of Brooklyn. It will be a drawbridge, the total length of which will be 144 ft., and is estimated to cost $70,000.

The New York, Ontario & Western has let a contract to the American Bridge Co., at $70,000, for six steel lattice through bridges consisting of nine spans, with an aggregate length of 1,000 ft.

OTTAWA, ONT.—Separate bids will be received by Joseph R. Roy, Acting Secretary of the Department of Public Works at Ottawa, Ont., until June 19, for the substructure and superstructure of the Des Joachims Interprovincial bridge across the north channel of the Ottawa River in Pontiac County. The plans and specifications may be seen at the post office at Pembroke or at the Department of Public Works in Ottawa.

PARMA, MICH.—See Detroit, Mich.

PHILADELPHIA, PA.—Bids will be opened by the Director of Public Works on the 14th for bridges as follows: Luzerne street, under North Pennsylvania Railroad, $91,000; Oak Lane, over North Pennsylvania Railroad, $20,000—one-half to be paid by the railroad company; Gibson avenue, over Baltimore & Philadelphia Railroad, $30,000. These bridges were authorized last December. Of the authorized bridges there are two yet to be awarded. One is on Dauphin street, under the P. & R., estimated to cost $40,000. The other is on Passayunk avenue over the Schuylkill River, for which $75,000 is available to start the work. The latter will probably be a bascule drawbridge.

TOLEDO, OHIO.—The Toledo Terminal Ry. Co. has asked the Secretary of War for permission to increase the number of piers in the Maumee River for its proposed bridge six miles above Toledo. According to the plans approved by the Department some time ago, the bridge was to have four piers with spans of 300 ft. each, and a draw span over the channel. The company wants double the number of piers. The bridge, as first planned, would cost about $275,000.

RUTLAND, VT.—It is reported that bids are being received by H. B. Whittier, Purchasing Agent, for a steel truss bridge of two spans, one 100 ft., and the other 75 ft., with 16-ft. roadway.

STAFFORD, N. Y.—The New York Central & Hudson River R. R., according to report, will build an overhead bridge in the northern part of this town at a cost of about $23,000. (See New York.)

STOCKTON, CAL.—We are told that bids are wanted July 2 by the County Clerk for a steel bridge over the San Joaquin River at Dunham's Ferry. There will be one 259-ft. draw span and two 70-ft. pony trusses. The substructure and superstructure will be let in one contract. The foundations will be on steel cylinders. The total cost is estimated at $19,000. F. E. Quail, County Engineer.

UTICA, N. Y.—The Osborn Engineering Co., of Cleveland, Ohio, is making plans and specifications for two bridges over the Erie Canal for the Utica Belt Line Street R. R. One bridge will be at Stanwix. The other at Frankfort.

VANCOUVER, WASH.—We are told that estimates are now being made for a bridge over the Columbia River at Vancouver, for the Washington & Oregon Ry. Address Edmund Rice, General Manager, Olympia, Wash.

WASHINGTON, D. C.—Bids are wanted, until noon of June 16, at the office of the Commissioners of the District of Columbia, for a concrete arch bridge across Broad Branch on Argyle Road. Lansing H. Beach, Commissioner.

According to report, plans have been made for two bridges in Rock Creek Park.

WILMINGTON, DEL.—The Board of Commissioners contemplate building a bridge across Clayton street in South Brandywine Park. Estimated cost, $6,000.

Other Structures.

BINGHAMTON, N. Y.—The Erie R. R., according to report, will build a depot in this city.

BIRDSBORO, PA.—The E. & G. Brooke Iron Co. propose to build a steel casting plant here, to be operated in connection with the plant of the Diamond Drill & Machine Co., which is owned by them. The buildings, dimensions of which will be 360 x 250 feet, will contain two open hearth furnaces of about 20 tons capacity, moulding and cleaning shops, core ovens, with the necessary cranes, etc. No contracts have been placed. The cost of the plant will not be a million dollars, as reported.

BOISE, IDAHO.—The Oregon Short Line Ry. has a franchise from the city to run a branch line down to the Boise River where a large warehouse will be built.

BOSTON, MASS.—Work will soon be begun on the large grain elevator for the Boston & Albany at East Boston, with a capacity of about 2,000,000 bushels. New freight sheds will also be built along the wharves which will have a total covered area of about 354,000 sq. ft. The cost of these improvements will approximate $2,000,000.

CLINTON, IOWA.—We are told that the matter of building a new depot for the Davenport, Rock Island & Northwestern in Clinton is not definitely decided.

NEW ORLEANS, LA.—The Rosenbaum Grain Company, of Chicago, Ill., is reported contemplating building a steel grain elevator in New Orleans.

MEETINGS AND ANNOUNCEMENTS.

(For dates of conventions and regular meetings of railroad associations and engineering societies see advertising page xxiv.)

Traveling Freight Agents' Association.

The annual meeting of this Association was held at Detroit last week. The president for the ensuing year is Mr. T. F. Sweat, of Chicago; secretary, Thomas Smiley, of Indianapolis.

The Very Latest.

The American Association of Dining Car Superintendents met at Detroit June 10. Twenty of the largest railroads of the country were represented. The following officers were elected: President, G. T. Spillman, Chicago; secretary, W. M. Wells, Chicago.

Engineers' Club of St. Louis.

The 528th meeting was held June 5, Vice-President Kinealy presiding. Attendance, 24 members and 10 visitors. The subject of the evening was a paper by Mr. A. H. Blaisdell entitled "The Western River Steamboat." Mr. Blaisdell exhibited lantern slides from photographs and drawings, and detailed some tests of steamboat performances, illustrated the path of the paddle wheel and its slip, gave examples of speed calculations and outlined the method of designing a steel hull, with calculations of stability, strength, etc. Adjourned until September 18, when Mr. J. A. Ockerson will present a paper entitled "The Mississippi River, Physical Characteristics and Methods of Improvement."

Accounting Officers.

The Thirteenth Annual Meeting of the Association of American Railway Accounting Officers was held at Denver, Colo., on May 29 and 30, with an attendance of about 140.

Mr. I. G. Ogden, Comptroller of the Canadian Pacific, President of the Association, presided. In his opening address he recommended that the Executive Committee be authorized to give decisions on questions concerning classification of operating questions presented by the statistician of the Interstate Commerce Commission or by members. At present such questions cannot be answered until the Association considers them at the annual meeting, which causes long delays.

The time of the Convention, the two days it was in session, was mostly taken up in discussing matters pertaining to the Interstate Commerce Commission's Classification of Operating Expenses, a revision of which has been under consideration by the Executive Committee of the Association during the past year. The question of Settlements with the Government for Transportation and matters relating to Waybills in use by Fast Freight Lines, also Settlement of Freight Claims, were considered and acted upon. Mr. A. D. Parker, General Auditor of the Colorado & Southern, read an address on Material Accounts, a report of which we must defer to another issue.

The election of officers for the ensuing year resulted as follows: President, H. C. Whitehead (A., T. & S. F.); secretary, C. G. Phillips, Chicago. The next annual meeting was appointed to take place at Philadelphia, May 28, 1902.

National Association of Manufacturers.

This Association held its sixth annual convention in Detroit June 4, 5 and 6. In looking over the annual address of the President, Mr. T. C. Search, we find the following passages:

RAILROAD REGULATIONS.

The passage of certain amendments to the Interstate Commerce law was most earnestly advocated by various commercial organizations, and a large volume of information was secured by the Senate committee bearing upon this particular act of legislation, with the result that the committee rejected the measure and returned it to the Senate without recommendation. The bill made no further progress, and the subject is now open for renewed consideration. A combination of the larger railroad corporations of the country in a "community of interests" has so far simplified and modified competition between lines as to render it improbable that the railroad companies will demand again the privilege of pooling. It may be said, therefore, that this vexatious disturbing element, upon which the commercial community was seriously divided, has been eliminated from the question. If the subject of amending the Interstate Commerce law shall be discussed again, it will probably be upon the lines of increasing the power of the Commission, a proposition against which will be arrayed all the power, influence and intelligence of the common carriers of the country.

EXPORT TRADE.

To impress the magnitude of the export trade of the United States more forcibly upon the members of this Association I append a table which shows the growth of the total exports and the exports of manufactured articles from the United States since 1821. The values are given in millions (six ciphers omitted).

Exports from the United States—1821-1901

Years.	Total exports.	Exports of manufactures.	P. c. of manufactures in total.
1821	$44	$6	12.88
1825	67	10	15.11
1830	59	9	15.08
1835	100	12	11.75
1840	112	14	12.85
1845	98	17	17.17
1850	135	23	16.77
1855	193	40	20.60
1860	316	40	12.76
1865	259	86	33.14
1870	455	68	15.00
1875	559	126	22.58
1880	824	103	12.48
1885	727	147	20.25
1890	845	151	17.87
1895	793	184	23.14
1896	863	229	26.47
1897	1,032	277	26.78
1898	1,210	291	24.02
1899	1,204	340	28.21
1900	1,371	434	31.65
1901*	1,120	305	27.21

*Nine months ended March 31, 1901.

The Engineers' Club of Philadelphia.

The members of the club, on the invitation of Mr. C. M. Mills, inspected the new Gray's Ferry Bridge on Saturday, June 8, at 3 p. m.

THE DUTY OF THE ENGINEER.

At the meeting on June 1 Professor Edgar Marburg opened a topical discussion by the presentation of a paper on the duty of the engineer to himself and his profession. He pointed out that by furthering or hindering the interests of his profession he will improve or injure his own reputation, as the two duties are inseparable. He should hold high professional ideals and make a conscientious effort to apply them to himself in all his professional relations. He should avoid the danger of degenerating into a narrow specialist by keeping in touch with the world of men and affairs, and by taking an interest in all higher lines of human endeavor.

Mr. L. Y. Schermerhorn discussed the duty of the engineer to his contractors and employers. The engineer in responsible charge of work being done under contract is assumed to be an expert in the work which he directs, and is by the specifications usually made the only recognized interpreter of the meaning of the plans. The engineer owes to his employer the duty of furthering his interests, but this should not prevent him from recognizing the duty which he also owes to the contractor to furnish him with correct information upon all matters involved in the work. He should treat all situations and conditions which may arise with judicial fairness, and while entitled to insist upon the proper execution of the work he should not forget that his contractor has rights for which honesty and justice demand fair recognition.

Mr. John C. Trautwine, Jr., discussed the duty of the engineer to the public. The modern methods of combining various business enterprises under one management have entered the field of engineering, so that now a large proportion of the profession are employees either of the municipality or of giant corporations. The conditions are becoming more and more different from what they were when an engineer was an independent professional man. The public engineer is and probably will remain a mere subordinate to a public servant of higher rank, and it is a nice problem for the conscientious engineer to properly serve this superior and the general public. It lies within the power of every man to be of value to his day and generation by contributing to the general intelligence and enlightenment—occasionally by precept, but always and chiefly by the example of his own life.

Mr. William Copeland Furber discussed the unfortunate feeling of superiority which some engineers and architects hold in dealing with contractors.

A verbal discussion followed, which was participated in by Messrs. James Christie, John Birkinbine, Arthur Falkenau, A. H. Holcombe, Max Livingston, and others.

Master Mechanics' Convention.

The American Railway Master Mechanics' Association will meet in its Thirty-fourth Annual Convention at 9 a. m., on Wednesday, June 19, at Saratoga, N. Y. Reading and discussing questions propounded by members is the special order from 12 noon until 1 p. m. of each day. The committee on subjects proposes the following for topical discussion:

1. The proper method of lubricating locomotive driving and truck axles. To be opened by Mr. G. R. Henderson.
2. What materials should be used for hub liners on cast steel driving wheels, and on the faces of cast steel driving boxes? To be opened by Mr. D. F. Crawford.
3. Should side parallel rods be in position on locomotives while in transit? To be opened by William Garstang.
4. Wanted: A design of piston followers, bull ring and packing ring for cylinders of large diameter that avoids the necessity of removal of piston from cylinder to change rings, the removal of piston on account of wear, the use of snap rings and the use of riveted followers. To be opened by Mr. William McIntosh.
5. The best material for crank pins. To be opened by Mr. John Mackenzie.
6. Reformation of the motive power department of the average American railway. To be opened by Mr. S. M. Vauclain.
7. The use of nickel steel in locomotive construction. To be opened by Mr. Robert Quayle.
8. The maintenance and lubrication of metallic piston rod packing. To be opened by Mr. D. Van Alstine.

Under the head of "Reports of Committees" will come the following reports:

1. Relative Merits of Cast Iron and Steel Tired Wheels.—J. N. Barr, chairman; A. M. Waitt, A. L. Humphrey, H. S. Hayward, and John Hickey.
2. Ton Mile Statistics.—H. J. Small, chairman; C. H. Quereau, and W. H. Marshall.
3. What Is the Cost of Running High Speed Passenger Trains?—William McIntosh, chairman; F. A. Delano and G. F. Wilson.
4. The Most Satisfactory Method of Handling, Cleaning and Setting Boiler Tubes.—W. H. V. Rosing, chairman; A. E. Miller and C. H. Doebler.
5. What Is the Most Promising Direction in Which to Effect a Reduction in Locomotive Coal Consumption?—A. E. Manchester, chairman; A. Forsyth and A. F. Stewart.
6. What Should Be the Arrangement and Accessories of an Up-to-Date Roundhouse?—Robert Quayle, chairman; V. B. Lang and D. Van Alstine.
7. Maximum Monthly Mileage That Is Practicable and Advisable to Make; How Best to Make It, Both in Passenger and Freight Service.—T. H. Symington, chairman; G. F. Wilson and Mord Roberts.
8. What Is the Most Approved Method for Unloading Locomotive Coal, Prior to Being Unloaded on the Tank.—William Gairstang, chairman; T. S. Lloyd, and W. E. Symons.
9. Subjects.—W. H. Marshall, chairman; S. M. Vauclain and A. J. Pitkin.
10. Advisability of This Association Joining the International Association for Testing Materials.—S. M. Vauclain, chairman; H. S. Hayward and T. W. Gentry.
11. Establishment of a Library in Connection With the Master Car Builders' Association.—A. M. Waitt.
12. Index of Proceedings.—F. A. Delano, chairman; S. P. Bush and C. M. Mendenhall.

The following individual papers will be presented:

Paper entitled, "A Classification of Locomotives," by R. P. C. Sanderson.

Paper, entitled, "A Practical Tonnage Rating," by G. R. Henderson.

PERSONAL.

(For other personal mention see Elections and Appointments.)

—Mr. Edward Manning Bigelow has been re-appointed Director of the Department of Public Works of Pittsburgh, Pa., succeeding George W. Wilson, who succeeded him in June, 1900. Until last year Mr. Bigelow was Director of the Department from the time that office was created, about 12 years ago.

—Mr. Henry A. Ziesel, the new Superintendent of the Western Division of the Lake Shore & Michigan Southern, is 39 years old. He began work for the company as a telegraph messenger boy at the age of 13. He soon secured a clerkship and later became assistant yardmaster. All but two years Mr. Ziesel has spent in Elkhart. These two years were spent in the freight department at Chicago.

—Mr. George B. Warfel, Assistant General Passenger Agent of the Baltimore & Ohio Southwestern, died Wednesday, June 5, at Danville, Ill. Mr. Warfel was 40 years old and had been engaged in railroad service since 1878, when he was train despatcher for the Indianapolis, Bloomington & Western. In 1893 he became Assistant General Passenger Agent of the Baltimore & Ohio Southwestern.

—Mr. Alfred De Forrest Keys, Vice-President of the New Jersey Dry Dock & Transportation Company, died Sunday of this week in Elizabeth, N. J., from appendicitis. He was born March 9, 1848, at Danbury, Conn., and had been for many years in the employ of Messrs. De Voe & Co., and was well known in the railroad trade. He was a member of the New York Railroad Club, the Engineers' Club of New York, and of other social and technical bodies.

—Mr. Daniel Bontecou announces that he has opened an office as a consulting engineer in the Heist Building, Kansas City, Mo. Mr. Bontecou has long been well known in railroad circles as well as in general engineering. For some time he has been Chief Engineer of the Kansas City, Ft. Scott & Memphis, and he has had much street railroad experience. He became a member of the American Society of Civil Engineers in 1879 and served a term as director, 1896-1898.

—Mr. Francis J. S. Hopwood, C.B., C.M.G., has been appointed Permanent Secretary to the British Board of Trade, in the place of the late Sir Courtenay Boyle, K.C.B. Mr. Hopwood was born in 1860, and entered the Board of Trade in 1886 as assistant law clerk. When, in 1893, the late Sir Courtenay Boyle succeeded Sir Henry G. Calcraft as Permanent Secretary, Mr. Hopwood was appointed Secretary of the Railroad Department. In that department he has been especially connected with legislation for the promotion of light railroads, the development of electric traction, the prevention of accidents to railroad employees, and the regulation of their hours of labor. Mr. Hopwood was created C.M.G. in 1893. In 1895 he was a British delegate to

the International Railway Congress and was then made C.B.

—Mr. Daniel Willard, the new Assistant to the President of the Erie Railroad, was born at North Hartland, Vt., Jan. 28, 1861. He was graduated from the Windsor High School in 1878 and the next year entered the service of the Vermont Central in the track department. In July of the same year (1879) he became locomotive fireman of the Passumpsic Road and continued with this company until 1883 as fireman and locomotive engineer. He resigned this position to become locomotive engineer on the Lake Shore & Michigan Southern. In 1884 he was connected with the Minneapolis, St. Paul & Sault Ste. Marie as locomotive engineer. He was promoted to Trainmaster and Superintendent, and remained with this company until February, 1899, when he was appointed Assistant General Manager of the Baltimore & Ohio. In May of this year Mr. Willard assumed his new duties, those of Assistant to the President of the Erie.

—Mr. George W. Bentley, formerly for many years a well-known railroad superintendent in New England committed suicide at Norwich, Conn., on the night of June 5. He arrived in Norwich on the afternoon of that day from Pittsburgh, Pa., and went to the grave of his daughter in the Norwich cemetery and there shot himself. Mr. Bentley was born at Norwich, and was 79 years old. His first railroad service was on the Worcester & Nashua, in the accounting department; and he was Superintendent of that road from 1853 to 1866. In the last-named year he went to the New London Northern where he remained three years. He then went to Florida, but in a few months came back north and for four years (1870-1874) was General Manager of the New Jersey Southern. He then went back to the New London Northern and had charge of that road for nine years, being also for a part of the time General Manager of the Central Vermont. In 1883 he again went to Florida, this time as General Manager of the Jacksonville, Tampa & Key West, remaining there five years. Since 1888 he has been interested in a number of new roads and in the railroad supply business. Of late years he had lived in New York city most of the time.

ELECTIONS AND APPOINTMENTS.

Atchison, Topeka & Santa Fe.—A. H. Payson has been appointed Assistant to the President. G. T. Neubert, Division Master Mechanic at Topeka, Kan., has resigned.

Bessemer & Lake Erie.—E. H. Utley, heretofore General Freight and Passenger Agent, has been appointed General Manager, with supervision over matters pertaining to the freight and passenger departments, succeeding F. E. House, resigned. The position formerly held by Mr. Utley has been abolished. O. J. Hammon has been appointed General Freight Agent and E. D. Comstock, General Passenger Agent, effective June 11.

Big Stony.—F. E. Bastian has been appointed Auditor, with headquarters at Narrows, Va.

Burlington & Northwestern.—M. Law has been appointed Assistant General Freight and Passenger Agent.

California Eastern.—E. C. Hall has been appointed Auditor and General Freight and Passenger Agent, with headquarters at Manvel, Cal.

Cape Girardeau, Bloomfield & Southern.—F. M. Dozier has been appointed Auditor, succeeding Peter Maul, resigned.

Chicago, Lake Shore & Eastern.—The headquarters of L. W. McNamee, Division Superintendent, have been removed from Milwaukee, Wis., to Bay View, Wis.

Chicago, Rock Island & Pacific.—At a meeting, held June 5, W. H. Moore and D. S. Reis were elected Directors, succeeding H. M. Flagler and H. A. Parker, respectively.

Chicago, St. Paul, Minneapolis & Omaha.—Eugene E. Osborne has been elected Vice-President and Assistant Secretary, succeeding M. L. Sykes.

Cincinnati Northern.—C. E. Schaff has been elected Vice-President and Treasurer, with headquarters at Cincinnati, Ohio.

Cincinnati, Portsmouth & Virginia.—Allen Hull, with the title of Division Passenger Agent, will assume the duties heretofore discharged by the Assistant General Passenger Agent, T. D. Rhodes.

Cumberland Valley & Waynesboro.—The officers of this company, recently organized, are: President, M. C. Kennedy, and Secretary, W. L. Ritchey. The Directors are: H. Gehr, D. M. Good, S. B. Rinhart, Dr. A. H. Strickler, E. Frick and G. W. Smith. (See R. R. News column.)

Detroit Southern.—The officers of this company are: President, Samuel Hunt; Vice-President, S. J. Listman; Treasurer and Assistant to the President, T. D. Rhodes; Auditor, W. D. Gray; General Superintendent, F. E. Dewey, and General Freight and Passenger Agent, Frank Ferris.

Duluth & Iron Range.—F. E. House, heretofore General Manager of the Bessemer & Lake Erie, has been elected President of the D. & I. R.

Florida East Coast.—W. L. Singleton, heretofore Acting Master Car Builder, has been appointed Master Car Builder.

Georgia, Florida & Alabama (Georgia Pine).—M. C. Hammond has been appointed Auditor, with headquarters at Bainbridge, Ga., succeeding G. N. Saussy.

Great Northern of Canada.—Guy Tombs has been appointed General Freight and Passenger Agent, with headquarters at Quebec, Que.

Hot Springs.—At a meeting, held June 1, the following officers were elected: President, F. I. Gowen; Treasurer, J. P. Hood, and Secretary, F. A. Bill.

Kansas City, Fort Scott & Memphis.—George A. Hancock, heretofore Superintendent of Machinery of the St. Louis & San Francisco, will, on June 30, take charge of the mechanical department of both companies, succeeding W. A. Nettleton, Superintendent of Motive Power and Machinery of the K. C., F. S. & M., resigned.

Kentucky & Indiana Bridge.—H. B. Spencer has been elected President, with headquarters at St. Louis, Mo.

Lake Shore & Michigan Southern.—M. S. Chase, Assistant General Freight Agent, with headquarters at Chicago, Ill., has resigned.

Marietta, Columbus & Cleveland.—J. K. Macdonald has been appointed General Superintendent, with headquarters at Marietta, Ohio, succeeding D. B. Cunningham.

Maryland & Pennsylvania.—J. S. Bull has been appointed General Freight Agent, relieving J. R. Klinefelter, General Freight and Passenger Agent, to this extent.

Mason City & Fort Dodge.—J. W. Colt has been elected President, with headquarters at Fort Dodge, Iowa.

Mexican National.—C. W. Fish has been appointed Auditor, succeeding D. P. Bennett, resigned. E. E. Bashford succeeds Mr. Fish as Assistant Auditor, with headquarters at Mexico, Mex.

Nacozari.—J. T. Logan, heretofore General Traffic Agent of the Rio Grande-Sierra Madre & Pacific, has been appointed General Superintendent of the Nacozari. (See R. R. Construction Supplement, March 8, 1901.)

Ohio Southern.—On June 1 Samuel Hunt became Manager for the Purchasers. C. D. McKelvey having resigned F. E. Dewey has been appointed General Superintendent with headquarters at Springfield, Ohio.

Oregon Short Line.—C. J. McNitt has been appointed Acting Auditor, succeeding F. W. Hills.

Pacific & Idaho Northern.—N. W. Bethel has been appointed Chief Engineer, with headquarters at Weiser, Idaho.

Pawnee.—Morgan Jones has been elected President, H. Burrell, Vice-President and General Manager, and H. White, Secretary and Treasurer.

Pennsylvania Company.—At a meeting of the Board of Directors, held June 7, James J. Turner was elected Fourth Vice-President of this company, and the Pittsburgh, Cincinnati, Chicago & St. Louis, succeeding L. F. Loree, resigned. George L. Peck has been appointed General Manager of both companies, succeeding George L. Potter, resigned. Thomas B. Hamilton succeeds L. G. Haas as Superintendent of the Erie & Ashtabula Division (Northwest System) of the Pennsylvania Company. Ralph Peters has been appointed General Superintendent of the P., C., C. & St. L., succeeding Mr. Peck, and Mr. Peters, in turn, is succeeded by James A. McCrea, as Superintendent of the Cincinnati Division (Southwest System).

Rio Grande Western.—At a meeting recently held in New York, E. T. Jeffrey was elected President, succeeding W. J. Palmer. At the same meeting the Directors of this company resigned and the following new Directors were elected: George Gould, W. S. Pierce, E. H. Harriman, L. Fitzgerald, J. H. Schiff and R. M. Galloway. (See R. R. News column, April 5, p. 246.)

Seaboard Air Line.—The headquarters of T. W. Whisnant, First Division Superintendent, have been removed from Portsmouth, Va., to Raleigh, N. C.

Southern Pacific.—A. Van Devender has been appointed Assistant Treasurer, succeeding F. H. Davis, resigned.

Tennessee Coal, Iron & Railroad.—G. B. McCormack, General Manager, has resigned.

Vandalia Line.—On June 10, the following appointments were made: H. I. Miller, General Manager, with headquarters at St. Louis, Mo.; Benj. McKeen, Superintendent of the Main Line Division, and W. C. Downing, Superintendent of the Peoria Division. Mr. McKeen's and Mr. Downing's headquarters will be at Terre Haute, Ind.

Waycross Air Line.—W. J. Swain has been appointed Auditor, succeeding F. M. Hawkins.

Wheeling & Lake Erie.—R. Blickensderfer, heretofore President and General Manager, will continue to discharge the duties of General Manager. Mr. Ramsey was recently elected President. (P. 341.)

RAILROAD CONSTRUCTION.

New Incorporations, Surveys, Etc.

BIRMINGHAM RAILWAY, LIGHT & POWER (ELECTRIC). Bids are asked for the extension of the line from Twenty-seventh street, Ensley, Ala., to Wylan.

CANADA NATIONAL RAILWAY & TRANSPORT.—A meeting of the provisional directors was held at Toronto, on June 5, for completing the organization of the company. The road is projected from Toronto northwest about 100 miles to Collingwood on the Georgian Bay, as a land link in the grain route between Duluth and the European markets. G. F. Piper, of Minneapolis, Minn., Frederick Kraus, of Milwaukee, Wis., and G. G. Barnham, of Duluth, represent the United States interests. S. F. McKinnon was elected Chairman; J. H. Boyle, Secretary, and J. B. McColl, Treasurer. On the Executive Board are: Frederick Wyld, James McMullen, Hon. Lyman Jones, Hon. A. T. Wood and Elias Rogers, Toronto; D. Wilson, of Collingwood, and Frederick Kraus, of Milwaukee. (Construction Supplement, March 8, 1901.)

CANADIAN PACIFIC.—Contracts will be let in a few days for the Calgary & Edmonton line from Strathcona to Edmonton, Man.

CHATEAUGUAY & NORTHERN.—Bids will be received, until June 18, for building the proposed line between Charlemagne, L'Assomption County, to the town of Joliette, Que., on the Great Northern of Canada. J. P. Mullarky, of Montreal, is Managing Director. (March 29, p. 229.)

CHATTANOOGA, DUCKTOWN & WALHALLA.—This company has been organized, with a capital stock of $3,000,000, to build from Chattanooga, Tenn., east about 150 miles to Walhalla, S. C. Among those interested are: O. W. Orton and N. H. Burt, of Chattanooga.

CHELAN TRANSPORTATION & SMELTING.—Grading is reported completed on two miles of this line from the mouth of Railroad Creek, Lake Chelan, Wash., to the company's property at Holden mines, in all 13 miles. It is intended to have the road completed by September. Fred R. Thompson is President, and R. D. Johnson, General Manager, both of the Jamieson Building, Spokane, Wash. (April 5, p. 245.)

CHICAGO & NORTHWESTERN.—The company, according to report, has bought land on the southwestern side of Sheboygan, Wis., to be used for yards.

CHICAGO, ROCK ISLAND & PACIFIC.—According to report, the company will build a branch from the Gowrie-Sibley Division to Spirit Lake, Iowa, this year, starting from Royal, Clay County, 24 miles.

It is also reported that the Winterset Branch from Des Moines to Winterset, Iowa, will be extended 12 miles to Macksburg, Madison County.

COLUMBIA, HUNTSVILLE & NORTHWESTERN.—Surveys are reported in progress for this line in Missouri from Columbia to Caynesville, on the Chicago, Burlington & Quincy. The Joplin Grading & Construction Co., of Fort Scott, Kan., is reported to have the contract for 20 miles. C. H. Hammett, Kansas City, Mo., is President, and C. J. Kilmer, of Huntsville, Chief Engineer.

COLUMBUS, WINCHESTER & LANCASTER TRACTION (ELECTRIC).—Building is to be begun in a few days on this line from Columbus southeast about 30 miles through Jefferson to Lancaster. It will be along the highway to Jefferson and thence over private right of way. Building is by the Philadelphia Construction Co. Howard C. Park, of Columbus, is interested. (Construction Supplement, March 8, 1901.)

DAYTON & WESTERN TRACTION (ELECTRIC).—Application has been made for an extension from Eaton, Ohio, northwest along the Eaton & Richmond pike to Richmond, Ind.

DES MOINES, NEVADA & ELDORA (ELECTRIC).—This company was incorporated in Iowa, June 5, with a capital stock of $50,000, to build from Des Moines via Nevada to Eldora. The route has been surveyed and part of the right of way obtained. H. H. Polk, of Des Moines, President of the Interurban Ry. Co., is President; W. F. Swayzee, of Nevada, Vice-President; Simon Cassady, of the Des Moines Savings Bank, Treasurer, and G. B. Hippee, Des Moines, Superintendent.

DULUTH, VIRGINIA & RAINY LAKE.—Surveys are reported completed for this line from Virginia, Minn., north about 50 miles toward the Rainy Lake country. The Cook & Turrish Lumber Co., of Duluth, is interested. (May 24, p. 357.)

EDGEMORE & MANETTA.—Surveys are completed and work will be begun in about a week on this line in South Carolina from Lando to Edgemore on the Seaboard Air Line. No contracts will be given. The maximum grade is 2 per cent. (S. C. Roads, May 31, p. 374.) B. D. Heath, of Lando, S. C., is President, and C. A. Spratt, Engineer. (Official.)

FINDLAY-MARION ELECTRIC.—The stockholders have completed the organization of this company and are making arrangements for surveys. W. E. Scofield, of Marion, Ohio, is President, and Asa W. Jones, of Youngstown, Vice-President. Notice of the incorporation was made last week. (June 7, p. 389.)

FONDA, JOHNSTOWN & GLOVERSVILLE.—An officer writes that the company has under survey an extension of the electric division of eight miles from Johnstown, N. Y., to Akin, connecting there with the Amsterdam Street railroad, in which the company has a controlling interest. Another extension to the east of the Amsterdam Street railroad is under survey from Amsterdam to Schenectady, 18 miles. There is under survey a branch from the Amsterdam Street north 3½ miles to Hagaman's, all of which will shortly be built. (June 7, p. 389.)

GRAFTON & UPTON.—This line, extending from North Grafton, Mass., to Milford, 16.5 miles, is reported to have bought the Milford & Worcester Street and proposes to equip its own line with electricity.

HARBOR SPRINGS.—This company has filed a map showing the location of the route of its proposed line in the village of Harbor Springs, Emmet County, Mich., with a crossing of the Grand Rapids & Indiana. It is supposed to be a logging road. Ephraim Shay is President and L. Shay, Secretary, both of Harbor Springs.

HOT SPRINGS.—Surveys are to be begun soon, according to report, for a connecting line to run from a point near Malvern, Ark., northeast into Little Rock to connect with the Choctaw, Oklahoma & Gulf, which has recently acquired the line. (Railroad News, June 17, p. 390.)

HOUGHTON COUNTY STREET (ELECTRIC).—This company is building a line from Houghton and Hancock, Mich., via Franklin, Jr., Osceola, Laurium, Red Jacket and Sentinel to Wolverine, 18 miles. It has seven miles of track from Franklin, Jr., to Red Jacket building by Clason & Davis, Opechee, Mich., of which six miles is completed to Laurium. Bids are in for the line from Calumet to Wolverine. J. H. Oakley, of Hancock, Mich., is Superintendent. (Official.)

ILLINOIS TERMINAL.—Surveys are made and most of the right of way obtained for an extension from Edwardsville, Ill., to Belleville, 14 miles.

INDIANAPOLIS & LEBANON TRACTION (ELECTRIC).—The company has decided to obtain a private right of way for its line from Indianapolis, Ind., northwest about 30 miles to Lebanon. A number of propositions have been received for financing. Oliver Ensley, of Indianapolis, is President. (Construction Supplement, March 8, 1901.)

INTERSTATE RAILWAY, LIGHT & POWER (ELECTRIC).—Surveys are completed for this proposed line from Paris, Ill., to Clinton, Ind., 56 miles. The maximum grades will be 2 per cent., and the sharpest curve 4 deg. There will be one bridge of 100 ft. span. (May 31, p. 374.) A. J. Hunter, of Paris, Ill., is president and Geo. R. Grimes, Engineer. (Official.)

INTERURBAN (ELECTRIC).—This company was incorporated in California May 13, with a capital stock of $1,000,000, to build from Los Angeles to Santa Ana, Orange County, with a branch from the San Gabriel River to City Long Beach. The incorporators are: M. R. Trask, J. M. Gardner, R. C. P. Smith, F. E. Trask and J. H. Stater, all of Los Angeles.

IOWA & ST. LOUIS.—This company has been incorporated to build a line in Adair County, Mo., between Novinger and Sibley Point, about five miles. J. B. Delaney and H. B. Kendrick, of Kansas City, Mo., are directors.

LEHIGH VALLEY TRACTION.—At a meeting of the stockholders and directors at Allentown, Pa., June 4, a number of extensions were agreed upon, including one from Macungie, Pa., through Alburtis to Temple, near Reading.

LIMA, LEWISTON & BELLEFONTAINE (ELECTRIC).—This company has been organized to build a line connecting the cities named. The road will connect at Lima with the proposed line to Columbus, and at Bellefontaine with a line to Fort Wayne. W. W. Fisher, of Bellefontaine, is President; W. P. Heston, of Toledo, Secretary; H. F. McCormick, of Columbus, General Manager; Ellis Bartholomew, of Lima, Assistant General Manager.

LOUISIANA ROADS (ELECTRIC).—Honorable Thomas A. Badeaux, Wm. H. Smith and L. H. Lancaster, of Thibodaux, are interested in a proposed line through the following towns: Donaldsonville, Plattenville, Napoleonville, Labadieville, Thibodaux, Raceland and Lockport, with a branch from Thibodaux, through Schriever to Houma. Building is assured but no surveys are made.

MARQUETTE, SPRING VALLEY & NORTHWESTERN.—Building is in progress on this line from Spring Valley, Ill., southwest six miles to Marquette, connecting the Chicago & Northwestern with the Marquette coal mines. J. S. Wylie, Davenport, Iowa, is President and Treasurer; J. F. Clark, of Davenport, Secretary, and C. S. Henning, of Marquette, Ill., Chief Engineer. (Official.)

MASON & OCEANA.—This company has filed a map for the proposed extension of this line from its present terminus at Hisperia, Mich., through Fremont to Newaygo, crossing the tracks of the Pere Marquette at Fremont, and at Newaygo.

MAUCH CHUNK, LEHIGHTON & SLATINGTON (ELECTRIC).—Building is reported begun on this line from Mauch Chunk, Pa., through Lehighton and Perryville to Slatington, 20 miles. I. A. Sweigard, of Philadelphia, is President. (May 24, p. 358.)

MEDIA, GLEN RIDDLE & ROCKDALE TROLLEY (ELECTRIC).—The Borough Council of Media, Pa., has granted right of way through the borough for this line to connect the cities named.

MONTANA & GREAT NORTHERN.—This company was incorporated in Montana, June 6, with a capital stock of $10,000,000, by James J. Hill and others interested in the Great Northern, to build that company's line from Jennings, Mont., north to the Canadian boundary and thence to the Crows Nest country. (G. N., May 17, p. 342.)

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE.—The company has filed notice with the South Dakota Secretary of State for a proposed extension from Ashley southwest 60 miles to the Missouri River. The same notice provides for an extension of 21 miles in North Dakota from Wishek to Ashley, for which contracts have been awarded to Halverson & Richards, of Minneapolis, Minn., and work is begun. (May 17, p. 342.)

The company also gives notice of an extension from Braddock to Bismarck, N. Dak., 40 miles.

MOHAWK RIVER TRACTION (ELECTRIC).—This company was incorporated in New York, June 10, with a capital stock of $160,000, to build a line 16 miles long through Nelliston, Fort Plain, Canajoharie and Sharon Springs.

MUNCIE, MIDDLETOWN & GREENFIELD TRACTION (ELECTRIC).—Funds are provided and the company is about ready to make surveys for its proposed line from Muncie, Ind., northeast 46 miles via Cross Roads, Middletown, Mechanicsburg, Shirley, Wilkinson, Warrington, Eden and Maxwell to Greenfield. Contracts for grading, etc., will be let in August or September. (June 7, p. 389.) Wm. H. Wood, of Muncie, is President and Chief Engineer, and W. L. McCampbell, of Middletown, General Manager. (Official.)

MUSQUODOBOIT.—The Nova Scotia Legislature has incorporated this company to build a line from Windsor Junction or Dartmouth, east 40 miles along the Musquodoboit Valley to Parker's Corners, with power to extend the line to Halifax. W. Yorston, C. E., under the direction of Provincial Engineer Murphy, made the original survey, which did not prove satisfactory, and a new survey is under consideration. Subscriptions have been received for $100,000 of stock. At the annual meeting just held J. W. Greer, of Montreal, was made President; H. Fitzpatrick, New Glasgow, N. S., Vice-President; W. C. Trotter, St. Johns, Que., Treasurer, and Dr. H. H. McKay, New Glasgow, Secretary.

NEWPORT & SHERMAN VALLEY.—Work is to be begun soon, according to report, on changing to standard gage the line from Newport, Pa., to New Germantown, 28.5 miles.

NEW YORK, NEW HAVEN & HARTFORD.—Plans are reported agreed upon for abolishing grade crossings at Acorn, Grove and Dike streets in Providence, R. I. (Construction Supplement, March 8, 1901.)

NEW YORK ROADS (ELECTRIC).—A company has been organized at Keuka to build a line from Dundee to Bradford, 16 miles. It is intended to begin surveys as soon as possible. George P. Lord, of Dundee, is President of the proposed company, and E. M. Sawyer, Secretary.

NORTHERN PACIFIC.—Contracts are reported let for betterments and improvements between Ellensburg and Spokane, Wash., to Nelson Rich, of North Yakima, Wash.

OHIO RIVER & LAKE ERIE.—Contracts have been let to A. W. McDonald for nine miles, and to Mathew Spellsey, 18 miles, both of Pittsburgh, on the extension from Bergholz, Ohio, southeast to Dillonvale, just west of Wheeling. (Construction Supplement, March 8, 1901.)

ONTARIO ROADS.—Premier Ross informs us that a survey of the line to the Temiscamingue District will not be made until the Colonization Agent, who is now in that region with 200 prospective settlers, has made his report. (May 31, p. 374.)

NORWOOD & ST. LAWRENCE.—The New York State Railroad Commission has granted authority to build this line from Norwood, N. Y., to Raymondville, 7½ miles. It is being built by the Remington-Martin Co., paper manufacturers of Watertown, N. Y. (April 19, p. 276.)

OHIO ROADS (ELECTRIC).—E. M. Kerlin, of the Kerlin Bros., 705 The Nasby, Toledo, O., writes that he is engaged in building the line from Port Clinton, Ottawa County, through Fremont to Tiffin, Seneca County, about 36 miles. About ten miles is graded and track laying will be begun in a few days. Contracts are let for a considerable portion of the material. George Champe, of Toledo, is the Chief Engineer.

PENNSYLVANIA.—Surveys are reported being made for a belt line at Camden, N. J., on the east side of Cooper's Creek from Federal street to Kaighn's avenue.

PENNSYLVANIA COMPANY.—The Cleveland, Akron & Columbus has been authorized by the Ohio Secretary of State to build its proposed branch from Apple Creek to Paint Township coal fields in Wayne County. (May 3, p. 308.)

RUMFORD FALLS & RANGELEY LAKES.—A petition has been filed with the Maine Board of Railroad Commissioners for an extension from Bemis to the south side of the outlet of Rangeley Lake, about nine miles.

SEATTLE-TACOMA INTERURBAN (ELECTRIC).—The company is arranging for a settlement with the Puyallup Indians for right of way across their reservation. The line is building between the cities named. Jacob Furth is President, and H. Day Hanford, Chief Engineer, both of Seattle. (May 31, p. 374.)

ST. JOHNS RIVER TERMINAL.—Officers of the Atlantic, Valdosta & Western have organized this company, with a capital stock of $100,000, to build a belt line at Jacksonville, Fla. George S. Baxter is President, and Walton Ferguson, Jr., Secretary and Treasurer.

ST. LOUIS, KANSAS CITY & COLORADO.—The Gasconade Construction Co., of St. Louis, has been awarded the contract for the extension from the Gasconade River, Mo., west 50 miles to the line of Miller County. (April 26, p. 292.)

SHEDIAC COAST.—Surveys have been completed as far as Shemogue, about 20 miles from Shediac, N. B., and it is the intention of the company to continue the survey on to Cape Tormentine, 20 miles more. A. L. Trueman, of St. John, N. B., is Treasurer. (Construction Supplement, March 8, 1901.)

SOUTHERN.—W. J. Oliver & Co. have taken the contract, according to report, for new grades and other improvements on the Asheville Division.

SOUTHERN PACIFIC.—An examination is reported being made for an extension from Klamathon, Cal., northeast about 50 miles up the river to Klamath Falls, Ore.

TAYLOR PARK.—This company has been incorporated in Colorado, with a capital stock of $1,000,000, to build a railroad from Aspen to Buena Vista. The incorporators are: A. A. Stewart, E. O. Chase and H. A. Olson, of Chicago, Ill.

TOLEDO & OHIO CENTRAL.—An officer writes with reference to the reported grading of an extension from St. Marys, Ohio, west, that such a branch has not been considered. (May 31, p. 374.)

WASHINGTON & PLYMOUTH.—This company is building a line 34 miles long from Washington, N. C., through Jackson, Hollis, Pinetown and Bunyon to Plymouth. Twenty miles is graded from Plymouth to Pinetown under the contract of Surry Parker, of Pinetown. E. A. Armstrong, of Camden, N. J., is President, and S. Parker, Pinetown, Chief Engineer.

WINSTON & WADESBORO.—At a recent meeting of the directors, held at Charleston, S. C., R. H. Rhett was elected President and Treasurer. It is stated that $150,000 capital has been subscribed. The road is projected from Winston-Salem south about 90 miles to Wadesboro, on the Atlantic Coast Line. (May 24, p. 358.)

Weand & McDermott, of Reading, Pa., are reported to have the contract for connecting the Northern Central with the Cumberland Valley at Harrisburg, Pa.

RAILROAD NEWS.

ATCHISON, TOPEKA & SANTA FE.—The company has taken over the title to the property of the San Francisco & Joaquin Valley, already operated as a part of the line. On June 5 Charles Steele, of the firm of J. P. Morgan & Co., was elected a director to succeed the late Aldace F. Walker, and was also made a member of the executive committee.

BLUE RIDGE—This line, from Anderson, S. C., to Walhalla, 34.02 miles, is ordered sold at Anderson, S. C., on July 15, to satisfy judgments against the road by the Southern Railway, amounting, with interest, to over $2,000,000. The upset price is $100,000. The road has been in the hands of a receiver since Dec. 15, 1894. It was controlled by the Richmond & West Point Terminal, but was not included in the reorganization for the formation of the Southern Railway.

CHATHAM & LEBANON VALLEY.—Dr. W. Seward Webb, chairman of the Board of Directors of the Rutland, is understood to have bought this property in the interest of the Rutland Company. The line extends from Bennington, Vt., the southern terminus of the Rutland, south 57 miles to Chatham, N. Y., at the junction of the Harlem River and the Boston & Albany divisions of the New York Central. The C. & L. V. is successor of the old Lebanon Springs, whose property was foreclosed in 1899. (C. & L. V., Nov. 10, 1899, p. 788.)

CHATTANOOGA, ROME & SOUTHERN.—The Central of Georgia took possession of this property on June 1. (March 22, p. 210.)

CHICAGO, BURLINGTON & QUINCY.—Holders of more than 96 per cent. of the capital stock have accepted the proposition to sell their holdings to the Great Northern and the Northern Pacific, and the time for depositing stock has been extended to July 15 next. Stock so deposited will be paid wholly in bonds. Holders of 5 per cent. convertible bonds, due Sept. 1, 1903, may convert them into stock at once, the stock to be deposited under the plan. (May 31, p. 374.)

CHICAGO, ROCK ISLAND & PACIFIC.—The stockholders, on June 5, adopted an amendment to the articles of consolidation authorizing the increase of capital stock from $50,000,000 to $60,000,000. Stockholders of record June 28 have the right to subscribe at par for the new stock in proportion of one share for each five now held, payment to be made on or before July 31. It is understood that the proceeds will be used for building the extension now under way from Liberal, Kan., to connect with the New Mexican Coal & Railway Company's line to El Paso.

CINCINNATI, JACKSON & MACKINAW.—A new committee, composed of William R. H. Martin, Henry F. Dawes and Albert R. Gallatin, makes the following announcement to holders of reorganization certificates:

> The Supreme Court having decided that security must be given to the stockholders of the Cincinnati, Jackson & Mackinaw Railway Company who have participated in the proceedings, the above named have consented to act as a committee for securing the distribution of the new stock provided in the plan of reorganization. There are no bonds outstanding on the main lines, and the last reported net earnings from operation are sufficient to pay 4 per cent. on the authorized issue of preferred stock. The amount of new common stock for distribution is limited to about $2,550,000. Certificates should be deposited with Schmidt & Gallatin, 45 Broadway, New York, in exchange for this committee's receipts, on or before June 18, 1901, as it is important, in the interest of the certificate holders, that very prompt action be taken for the protection of their interests. (May 31, p. 374.)

CUMBERLAND VALLEY & WAYNESBORO.—This company has been incorporated in Pennsylvania, as successor to the Mont Alto, sold at foreclosure on April 27. (May 10, p. 324.)

DES MOINES & FORT DODGE.—New control, it is understood, has been obtained of the majority stock of this line and an attempt is to be made to break the lease of the property to the Chicago, Rock Island & Pacific. The line runs from Des Moines, Iowa, to Fort Dodge, 88.51 miles, and from Tara to Ruthven, 55 miles. It was leased to the Rock Island for 18 years from Jan. 1, 1887.

DETROIT & LIMA NORTHERN.—Justice Kenefick, of Buffalo, on application of Wilbur C. Brown, has granted an injunction to restrain the reorganization committee from disposing of the property or issuing any bonds, pending an investigation of the charges of conspiracy against the bondholders. The property was recently sold at foreclosure and is to be consolidated with the Ohio Southern under the title of Detroit Southern. (May 31, p. 374.)

DETROIT & MONROE ELECTRIC.—The Everett-Moore syndicated, which controls the Detroit & Toledo Shore Line, has also bought the Detroit & Monroe Electric, both of which are partially completed between Detroit and Toledo.

DETROIT & NORTHWESTERN (ELECTRIC).—This line, whose sale was recently noted to the Detroit United, has been taken over by that property and is operated as the Farmington Division. (May 10, p. 324.)

EEL RIVER.—This property was sold at foreclosure at Logansport, Ind., June 10, to E. Smith, representing the stockholders' committee, for $1,000,000. (May 31, p. 374.)

HAMILTON & LINDENWALD ELECTRIC TRANSIT.—This line, about nine miles long, is reported sold to M. J. Mandelbaum, of Cleveland, Ohio, for the Southern Ohio Traction, which is to operate the property, it is said, in connection with its interurban line.

HARTFORD & SPRINGFIELD STREET (ELECTRIC).—The Enfield & Long Meadow Electric has changed its corporate name to the above title. An application will be made to the Superior Court at Hartford, Conn., on June 21, to confirm the same. New bonds will be issued for the proposed extension connecting the Springfield Street with the Hartford Street lines. (Enfield & Long Meadow Electric, May 24, p. 357.)

LAKE STREET ELEVATED (CHICAGO).—According to the *Chicago Economist*, the directors have resolved to limit the issue of first mortgage bonds under the present mortgage to $6,000,000. An instrument amendatory of the mortgage to this effect is to be placed at once on record. The original mortgage provided for an immediate issue of $6,500,000 and a further issue of $850,000 per mile on additional road. Outstanding bonds and debentures are guaranteed by the Northwestern and Union Elevated. (March 8, p. 178.)

LAKE SUPERIOR & ISHPEMING.—Forty-five first mortgage bonds of 1896 have been called for redemption at 105 and accrued interest, at the Farmers' Loan & Trust Co. on July 1 next. (Dec. 21, 1900, p. 852.)

MISSISSIPPI & LITTLE ROCK.—Judge Trieber, in the Federal Court at St. Louis has granted a decreee of foreclosure in the case of the St. Louis Trust Co., trustees, against this company, and the property is ordered sold July 1. The road was built in 1891 from Aurich to Ross, Ark., 27 miles, and a receiver was appointed in 1897, and operations were suspended.

MISSOURI PACIFIC.—Holders of $12,000,000 of the new 5 per cent. convertible bonds ($15,000,000 issued) have sent notice to the officers of the company that they intend to present their bonds to be exchanged for M. P. common stock. (July 20, 1900, p. 502.)

NEW ORLEANS & WESTERN.—Holders of first and second terminal mortgage bonds who have deposited them with the Colonial Trust Company under the plan of reorganization of Aug. 1, 1899, are notified that the committee will be prepared on and after June 12 to make final disposition of the proceeds of the foreclosure sale made March 9 last. The rate is $24.55 for each first terminal mortgage bonds, and $12.64 for the second bonds. (April 19, p. 276.)

PACHUCA, ZACUALTIPAN & TAMPICO.—A group of American capitalists (according to a City of Mexico despatch) have bought this property, which runs from Pachuca north to Trinidad and Apulco, Mexico, and will extend it on north to Tampico.

PENNSYLVANIA COMPANY.—The South Chicago & Southern and the State Line & Indiana City have been consolidated, with a capital of $1,000,000. These roads are owned and operated by the Pennsylvania.

PENNSYLVANIA ROADS.—The Governor of Pennsylvania has signed the Emery and Focht bills, which establish a general law in Pennsylvania for the incorporation of elevated and underground railroads, with surface rights. The Focht bill, in addition to providing for elevated and underground roads with surface rights, permits the operating of connecting lines on turnpikes and confers the right of eminent domain. The capital stock is to be not less than $50,000 per mile built and before articles of association are filed; at least $25,000 of the stock per mile must be subscribed, and 10 per cent. in cash paid to the directors, but the corporations are permitted to borrow money not to exceed the capital stock authorized. Under the Emery bill no street or boulevard is exempt, provided the City Councils see fit to grant the necessary franchises. There is a forfeiture of charter if the work is not begun within two years and completed within five years. The corporation may sell its own franchises and roads and acquire others by purchase. This right is not limited to corporations formed under these special acts. Under these laws a large number of charters have been taken out, among which are 13 by one set of men for lines in the city of Philadelphia. Among those interested in the Philadelphia lines are Robert E. Foerderer, James McNichol, Clarence Wolf and Michael Murphy, all of Philadelphia. Applications have also been made to the Philadelphia City Council for rights of way.

PHILADELPHIA & LEHIGH VALLEY TRACTION (ELECTRIC).—This company has made a mortgage to the Guaranty Trust Co., New York, as trustee, to secure $2,500,000 4 per cent. bonds. The mortgage is said to cover 55 miles of line to be built from Chestnut Hill, near Philadelphia, via Quakertown, to Mountainville, near Allentown; also a branch line. It is stated that the new bonds will be guaranteed by the Lehigh Valley Traction. Robert L. Johnson is president of both the Lehigh Valley Traction and the Philadelphia and Lehigh Valley Traction, and proposes ultimately to connect Philadelphia with New York. (Railroad Construction, March 20, p. 230.)

SOUTH BOUND.—Judge Gage, of South Carolina, has appointed a receiver for this property in a damage suit for $7,500. It is said that the proceeding cannot affect the plan of the consolidation of the property with the Seaboard Air Line. (May 24, p. 358.)

SOUTHERN.—Fifty-five Georgia Pacific equipment mortgage bonds have been drawn for payment from the sinking fund, at the Central Trust Co., New York, on Aug. 1, interest to cease from that date. (March 1, p. 152.)